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STATEWIDE AIR EMISSIONS CALCULATIONS FROM WIND AND OTHER RENEWABLES

SUMMARY REPORT

A Report to the
Texas Commission on Environmental Quality
For the Period September 2007 – August 2008

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August 2008

ENERGY SYSTEMS LABORATORY

Texas Engineering Experiment Station
Texas A&M University System

ENERGY SYSTEMS LABORATORY
Texas Engineering Experiment Station
Texas A&M University System

3581 TAMU
College Station, Texas 77843-3581

August 31, 2008

Chairman Buddy Garcia
Texas Council on Environmental Quality
P. O. Box 13087
Austin, TX 78711-3087

Dear Chairman Garcia:

The Energy Systems Laboratory (ESL) at the Texas Engineering Experiment Station of the Texas A&M University System is pleased to provide its third annual report, "Statewide Emissions Calculations From Wind and Other Renewables," as required by the 79th Legislature. This work has been performed through a contract with the Texas Environmental Research Consortium (TERC).

In this work the ESL is required to obtain input from public/private stakeholders, and develop and use a methodology to annually report the energy savings from Wind and Other Renewables. This report summarizes the work performed by the ESL on this project from September 2007 to August 2008.

Please contact me at (979) 845-1280 should you or any of the TCEQ staff have questions concerning this report or the work presently being done to quantify emissions reductions from energy efficiency and renewable energy measures as a result of the TERP implementation.

Sincerely,

David E. Claridge

David Claridge, P.E.
Director

Enclosure

cc: Commissioner Larry R. Soward
Commissioner Bryan W. Shaw
Executive Director Mark R. Vickery

Disclaimer

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SUMMARY REPORT

Statewide Air Emissions Calculations from Wind and Other Renewables

1. EXECUTIVE SUMMARY

The 79th Legislature, through Senate Bill 20, House Bill 2481 and House Bill 2129, amended Senate Bill 5 to enhance its effectiveness by adding 5,880 MW of generating capacity from renewable energy technologies by 2015 and 500 MW from non-wind renewables.

This legislation also requires the Public Utilities Commission of Texas (PUCT) to establish a target of 10,000 megawatts of installed renewable capacity by 2025, and requires the Texas Commission on Environmental Quality (TCEQ) to develop methodology for computing emissions reductions from renewable energy initiatives and the associated credits. In this Legislation the Energy Systems Laboratory (ESL) is to assist the TCEQ in quantifying emissions reductions credits from energy efficiency and renewable energy programs, through a contract with the Texas Environmental Research Consortium (TERC) to develop and annually calculate creditable emissions reductions from wind and other renewable energy resources for the State Implementation Plan (SIP).

The Energy Systems Laboratory, in fulfillment of its responsibilities under this Legislation, submits its third annual report, "Statewide Air Emissions Calculations from Wind and Other Renewables," to the Texas Commission on Environmental Quality.

The report is organized in several deliverables:

- A Summary Report, which details the key areas of work;
- Supporting Documentation; and
- Supporting data files, including weather data, and wind production data, which have been assembled as part of the third year's effort.

This executive summary provides summaries of the key areas of accomplishment this year, including:

- Continuation of stakeholder's meetings;
- Analysis of power generation from wind farms using improved method and 2006 data;
- Analysis of emissions reduction from wind farms;
- Updates on degradation analysis;
- Analysis of other renewables, including: PV, solar thermal, hydroelectric, geothermal and landfill gas;
- Review of electricity generation by renewable sources and transmission planning study reported by ERCOT;
- Review of combined heat and power projects in Texas; and
- Preliminary reporting of NOx emissions savings in the 2007 Integrated Savings report to the TCEQ.

1.1 Development of Stakeholder's meetings

Legislation passed during the regular session of the 79th Legislature directed the Energy Systems Laboratory to work with the TCEQ to develop a methodology for computing emissions reductions attributable to renewable energy and for the ESL to quantify the emissions reductions attributable to renewables for inclusion in the State Implementation Plan annually. HB 2921 directed the Texas Environmental Research Consortium (TERC) to engage the Texas Engineering Experiment Station for the development of this methodology.

During the 2007-2008 periods, Texas A&M held continuing Stakeholder's meetings in May 2007 and in March 2008. A presentation for the March 2008 meeting is contained in Appendix A of this report.

1.2 Analysis of wind farms using improved method and 2006 data

In this report the weather normalization procedures developed together with the Stakeholders were improved and applied to all the wind farms that reported their data to ERCOT during the 2006 measurement period, together with wind data from the nearby NOAA weather stations. In the 2007 Wind and Renewables report to the TCEQ (Haberl et al. 2007), weather normalization analysis methods were reviewed; an analysis was shown for the Sweetwater I wind farm in Nolan, Texas, and then applied to all the wind farms in the ERCOT region.

The same wind farm (Sweetwater I) was used as an example in this report to present the improved weather normalization procedure, including the processing of weather and power generation data, modeling of daily power generation versus daily wind speed using the ASHRAE Inverse Model Toolkit (IMT) (Haberl et al. 2003; Kissock et al. 2003) for two separate periods, i.e., Ozone Season Days period (OSP)and Non-Ozone Season days period (Non-OSP); prediction of 1999 wind power generation using developed coefficients from 2006 daily OSP and Non-OSP models; and the analysis on monthly capacity factors generated using the models.

Finally, a summary of total predicted wind power production in the base year (1999) for all of the wind farms in the ERCOT region using the developed procedure is presented to show the improved accuracy of using this two-model weather normalization procedure compared to the single-model weather normalization procedure reported in the 2007 report to the TCEQ. This includes an uncertainty analysis that was performed on all the daily regression models and included in this report to show the improved accuracy of applying the OSP and Non-OSP linear regression models to predict the wind power generation that the wind farms would have had in the base year of 1999. The detailed analysis for each wind farm is provided in the Appendix to this report. The original data used in the analysis is included in the accompanying CD-ROM with this report.

1.3 Analysis of emissions reduction from wind farms

In this report, the procedure for calculating annual and peak-day, county-wide NOx reductions from electricity savings from wind projects implemented in the Power Control Areas in ERCOT listed in the EPA's eGRID was presented, including assigning the wind farms to PCA based on the information provided by the PUCT, and calculating the NOx emission reductions based on the special version of eGRID developed by the EPA for the TCEQ. According to the developed models, the total MWh savings in the base year 1999 for the wind farms within the ERCOT region are 6,919,352 MWh and 15,269 MWh/day in the Ozone Season Period. The total NOx emissions reductions across all the counties amount to 4,059 tons/yr and 9 tons/day for the Ozone Season Period.

Another method for estimating the emissions reduction from the wind power using electricity sales data from each PCA was investigated and the results from comparing the two methods were presented. The ESL is currently in communication with the EPA and the TCEQ regarding new version of eGRID for all ERCOT counties in Texas. As the TCEQ moves the base year to more recent years and ERCOT is in the process of moving toward the Nodal market, an updated version of eGRID representing the Texas market in 2000-2007 will need to be created to estimate the emissions reduction from wind power.

1.4 Development of a degradation analysis

This report contains an updated analysis to determine what amounts of degradation could be observed in the measured power from Texas wind farms. Currently, the TCEQ uses a very conservative 5% degradation per year for the power output from a wind farm when making future projections from existing wind farms.

Accordingly, the TCEQ asked the ESL to evaluate any observed degradation from the measured data for Texas wind farms. To accomplish this, nine wind farms (12 sites) in Texas from 2002 to 2006 were evaluated. These wind farms were built before January 2002 with a total capacity of 1,010 MW.

In this analysis, a sliding statistical index was established for each site that uses 10^{th}, 25^{th}, 50^{th}, 75^{th}, 90^{th}, and 99^{th} percentiles of the hourly power generation over a 12-month sliding period, as well as mean, minimum and maximum hourly power generation of the same 12-month period. These indices are then displayed using one data symbol for each 12-month slide, beginning from the first 12-month period (January 2002 to December 2002) until the last 12-month period (January 2006 to December 2006) for each of the wind farms.

Of the 12 sites analyzed, nine sites showed an increase when one compares the 90^{th} percentile from January 2002 to December 2006 (a total of 5 years) to the 90^{th} percentile of the first 12-month period in 2002, ranging from 4.2% to 17.9%. The remaining three sites showed a decrease from -5.9% to -11.8%. The weighted average of this increase across all wind farms studied is 7.9% (positive), which indicates that no degradation was observed from the aggregate energy production from these wind farms over a five year operation period.

1.5 Analysis of other renewables

Other renewable energy projects throughout the state of Texas were located to determine NOx emissions reduction and are included in this section. Searches were conducted on five specific categories which include solar photovoltaic, solar thermal, geothermal, hydroelectric, and Landfill Gas-Fired Power Plants. Many newly located renewable energy projects are assembled for inclusion in this report.

1.6 Review of electricity savings and transmission planning study reported by ERCOT

In this report, the information posted on ERCOT's Renewable Energy Credit Program site www.texasrenewables.com is reviewed. In particular, information posted under the "Public Reports" tab was downloaded and assembled into an appropriate format for review. This includes ERCOT's 2001 through 2007 reports to the Legislature and information from ERCOT's listing of REC generators.

The optimization study of the transmission plans conducted by ERCOT, which is known as Competitive Renewable Energy Zones (CREZ), was reviewed to address the future wind development issues. The CREZ was selected based on areas of the state with the highest wind potential and the transmission of wind power to the load centers in ERCOT. The action plan from the PUCT regarding the CREZ is also included.

1.7 Review of Combined Heat and Power Projects in Texas

A summary of all the Combined Heat and Power (CHP) applications in Texas and analysis on how it can impact the NOx emissions were provided in this section. The complications involved in developing a methodology for calculating the emissions reduction from CHP were analyzed and presented.

1.8 Preliminary reporting of NOx emissions savings in the 2007 Integrated Savings report to the TCEQ

In this report, the preliminary 2007 cumulative NOx emissions savings are reported. These values represent the electricity and NOx emissions savings that are reported to the TCEQ through the integrated NOx emissions savings reporting procedures, which contain growth, discount, and degradation factors. The developed wind power daily models presented in this report were based on 2006 wind power generation data. In this section, 2007 wind power generation was assembled in the integration savings plots.

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2 INTRODUCTION

2.1 Statement of Work for Calculations of Emissions from Wind and Other Renewables

This summary report covers the Energy Systems Laboratory's work from September 2007 through August 2008. This work is intended to cover the basic work outline included below:

Task 1: Obtain input from public/private stakeholders.

Task 2: Develop a methodology in cooperation with the Texas Commission on Environmental Quality (TCEQ) and the U.S. Environmental Protection Agency (USEPA) for calculating emissions reductions obtained through wind and other renewable energy resources in Texas.

Task 3: Calculate annual, creditable emissions reductions for wind and other renewable energy resources for inclusion in the State SIP.

Task 4: Include emissions reductions by county from wind and renewable energy resources in the ESL's annual report to the TCEQ.

Task 5: Incorporate wind and renewable energy emissions reductions as a component of the ESL's annual *Clean Air Through Energy Efficiency Conference (CATEE)* to facilitate technical transfer.

2.2 Summary of Progress

The progress toward completing each task is provided in the following section and throughout this report.

Task 1: Obtain input from public/private stakeholders.

Legislation passed during the regular session of the 79th Legislature directed the Energy Systems Laboratory to work with the TCEQ to develop a methodology for computing emissions reductions attributable to renewable energy and for the ESL to quantify the emissions reductions attributable to renewables for inclusion in the State Implementation Plan annually. HB 2921 directed the Texas Environmental Research Consortium (TERC) to engage the Texas Engineering Experiment Station for the development of this methodology.

During the period from September 2007 to August 2008 several meetings were held to review the analysis methodology with ERCOT, NREL, and the TCEQ. In March 2008, a presentation was made to the TCEQ on the calculation of emissions reduction from energy efficiency, wind and renewable energy. Figure 11-1 through Figure 11-11 in Appendix A show the slides that were presented in that meeting.

Task 2: Develop a methodology in cooperation with the Texas Commission on Environmental Quality and the U.S. Environmental Protection Agency for calculating emissions reductions obtained through wind and other renewable energy resources in Texas.

This task is composed of the following subtasks:

- Review existing methodologies for calculating emissions reductions from wind energy and other renewable energy systems with USEPA, TCEQ and stakeholders. Develop acceptable methodologies for wind and renewables.
- Determine how to implement methodologies for Texas, including accounting of current installations, future sites, degradation, discounting/uncertainty, grid constraints, etc.

- Review methodologies for verifying wind energy production and renewable energy installations with TCEQ, USEPA and stakeholders. Develop acceptable methodologies for verifying installations, including documentation, EPA QAPP, etc.
- Develop draft State Guidelines for the TCEQ for EE/RE SIP credits.

Task 3: Calculate annual, creditable emissions reductions for wind and other renewable energy resources for inclusion in the State SIP.

This task is composed of the following subtasks:

- Calculate annual emissions from wind and other renewable energy projects.
- Verify annual installations of wind and renewable energy systems in Texas.
- Verify ERCOT historical data for wind production and other renewables.

Task 4: Include emissions reductions by county from wind and renewable energy resources in the ESL's annual report to the TCEQ.

This task is composed of the following subtasks:

- Report annual emissions from wind and other renewable energy projects.
- Report on verification of installations of wind and renewable energy systems in Texas.
- Develop documentation for all methods developed.

Task 5: Incorporate wind and renewable energy emissions reductions as a component of the ESL's annual *Clean Air Through Energy Efficiency Conference (CATEE)* to facilitate technical transfer.

Additional information regarding the ESL's efforts on Tasks 2, 3, 4 and 5 are listed in the following and presented in details in the following sections. This work was performed during the period September 2007 through August 2008.

- Analysis of wind farms using improved method and 2006 data;
- Analysis of emissions reduction from wind farms;
- Development of a degradation analysis;
- Analysis of other renewables;
- Review of electricity savings and transmission planning study reported by ERCOT;
- Combined Heat and Power projects in Texas; and
- Preliminary reporting of NOx emissions savings in the 2006 Integrated Savings report to the TCEQ.

3 ANALYSIS ON POWER PRODUCTION FROM WIND FARMS USING 2006 DATA

3.1 Introduction

Texas can now take its place as the largest producer of wind energy in the United States. As of November 2007[1] the capacity of installed wind turbines totals was 4,112 MW with another 1,478 MW under construction (Figure 3-1 and Figure 3-2). The capacity announced for new projects is 8,012 MW by 2011.

In this section, the weather normalization procedures developed and applied in the 2007 Wind and Renewable report to the TCEQ (Haberl et al. 2007) for predicting wind power production in the base year (1999) were refined to improve the accuracy of the estimation in Ozone Season Period. The refined procedure was illustrated in details using the Sweetwater I wind farm in Nolan, Texas, as an example. It was then applied to all the wind farms in the ERCOT region for calculating the power production in the 1999 base year using 2006 wind power data from ERCOT and wind speed data from nearby NOAA weather stations. A comparison between the estimated wind power in 1999 and the 1999 Ozone Season Period from the 2007 report and the results from this refined method are also included in this section to show the improved accuracy.

An uncertainty analysis was also performed on all the daily regression models and included in this report to show a higher accuracy of applying the OSP and Non-OSP linear regression models to predict the wind power generation that the wind farms would have had in the base year of 1999. The detailed analysis for each wind farm is provided in the Appendix to this report. The original data used in the analysis is included in the accompanying CD-ROM with this report.

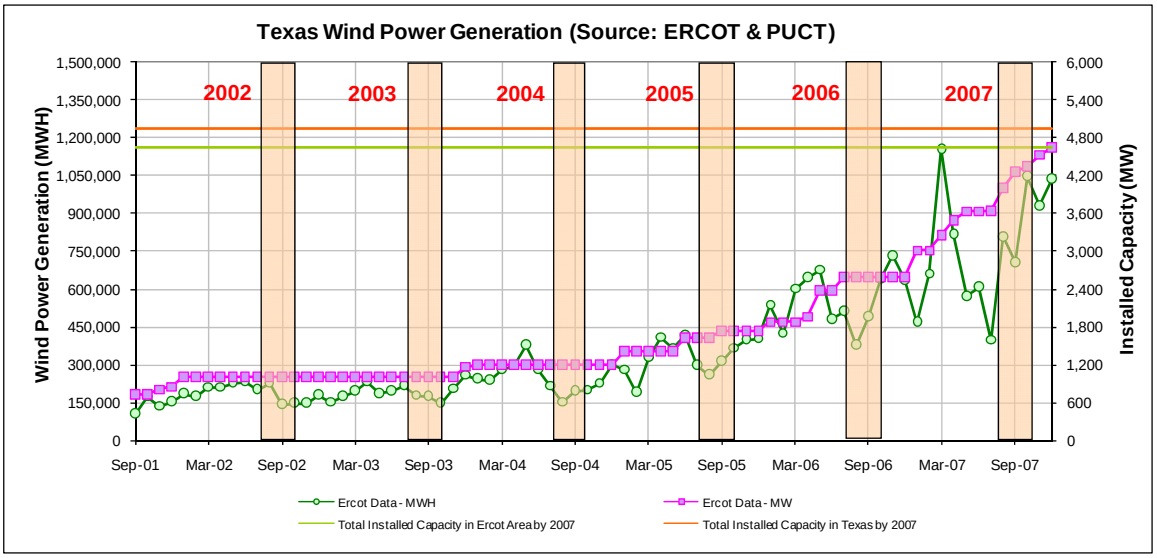


Figure 3-1: Installed Wind Power Capacity and Power Generation in the ERCOT region from 2001 to December 2007.

[1] Wind project information obtained from the Public Utility Commission of Texas (www.puc.state.tx.us) and the Electric Reliability Council of Texas (ERCOT).

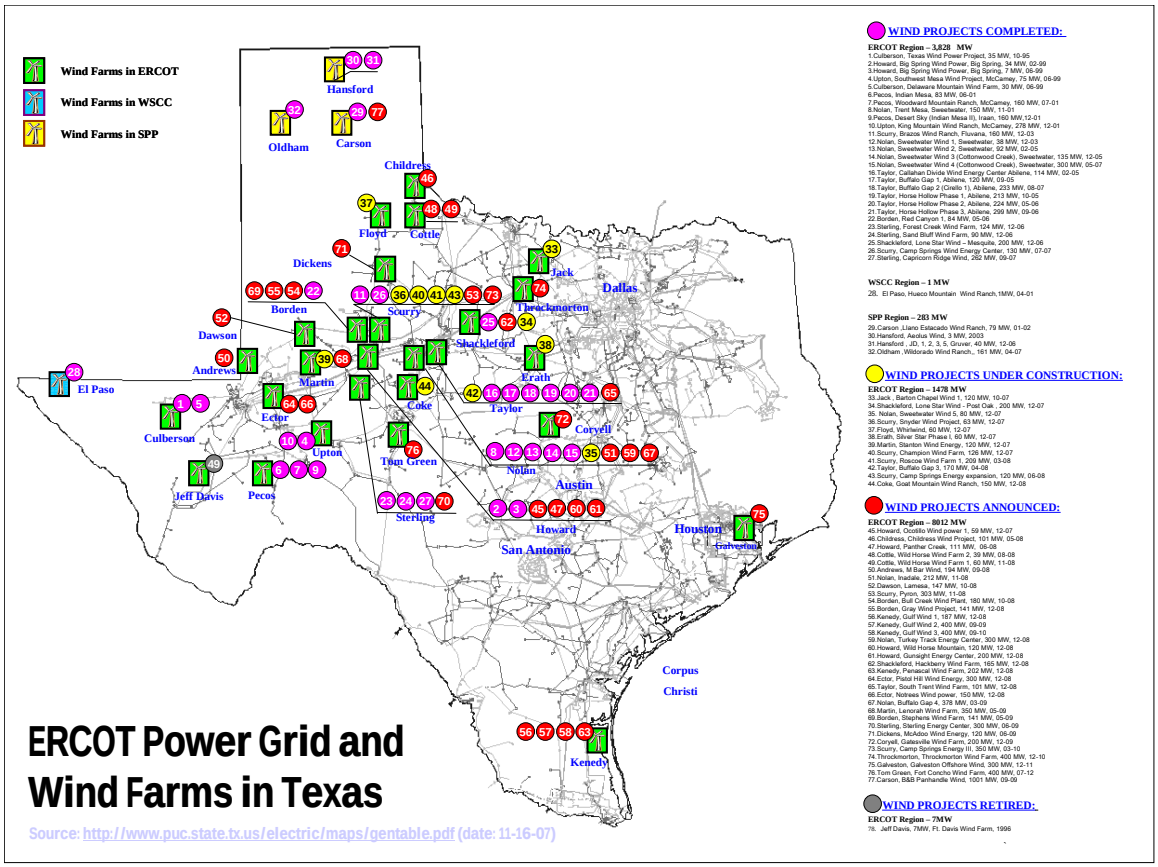


Figure 3-2: Completed and Announced Wind Projects in Texas by November 2007.

3.2 Overview of the Ozone Season Period and the NON- Ozone Season Period Methods

In the 2007 report, for the analysis of wind farms using 2005 data, an annual daily regression model was developed for predicting both annual power production and the average daily power production in the Ozone Season Days (OSD) period in base year 1999. As shown in Figure 3-3, the daily wind power from a wind farm was plotted against the average daily wind speed from the nearest NOAA weather station. The daily regression model developed using 365 days' data was imposed on top of the measured data. The orange data points show the measured daily wind power data in Non-Ozone Season Period while the green data points are the measured daily wind power in Ozone Season Period (OSP). It is noted that most of the data points in the Ozone Season Days were clustered below the regression model. Due to the reason that wind speed and other related weather conditions in summer could be different from other seasons for this site which may have an impact on the operation of the wind farm, it shows that the annual model could not present the reality of the wind power production in the summer season very well.

To improve the accuracy of the prediction in Ozone Season Days, in this report, for each wind farm, two models were developed for the Ozone Season Period 07/15/06 - 09/15/06 and the Non-Ozone Season Period 01/01/06 – 07/14/06 and 09/16/06 – 12/31/06, respectively. In Figure 3-4, the daily wind power is plotted against the NOAA-ABI Wind speed for the OSD period using the OSP model and for the rest of the period using a Non-OSP model for a wind farm. Figure 3-5 shows the time series plot of predicted daily wind power data, measured average daily power data and NOAA-ABI wind speed during the OSP 2006 using the annual model. Figure 3-6 shows the same time-series data for the same period but using the OSP model. Table 3-1 summarizes the difference between the measured and predicted power production for each month and Ozone Season Period using both methods. It clearly shows that the OSP model tracked the measured daily power more closely (an error of 0% for the OSP) than the annual model (an error of -19.4% for the P) and thus can significantly improve the accuracy of predicting power production in the Ozone Season Days of the selected base year.

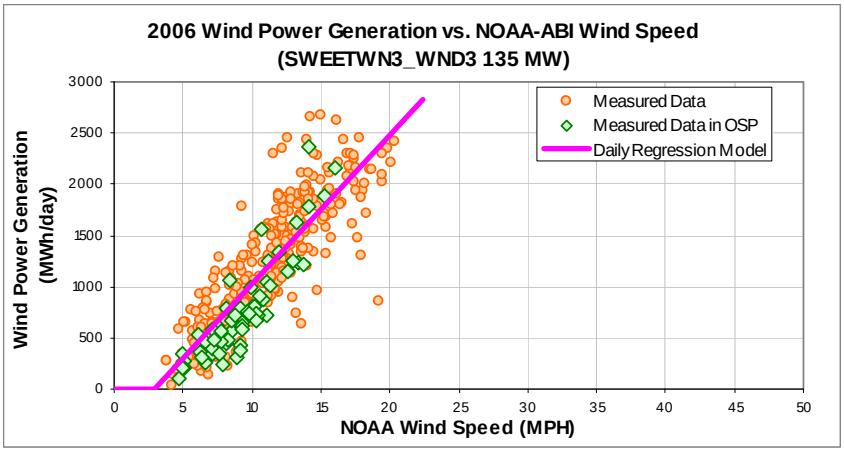


Figure 3-3: Daily Wind Power vs. NOAA-ABI Wind Speed Using Annual Model.

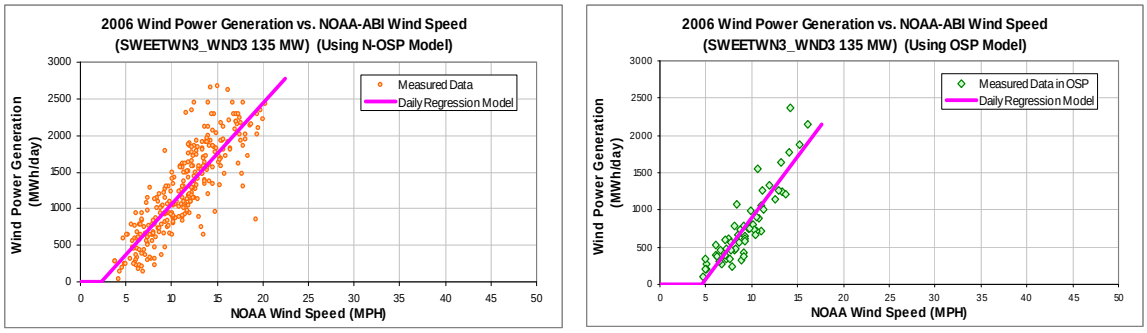


Figure 3-4: Daily Wind Power vs. NOAA-ABI Wind Speed Using OSP and Non-OSP Models.

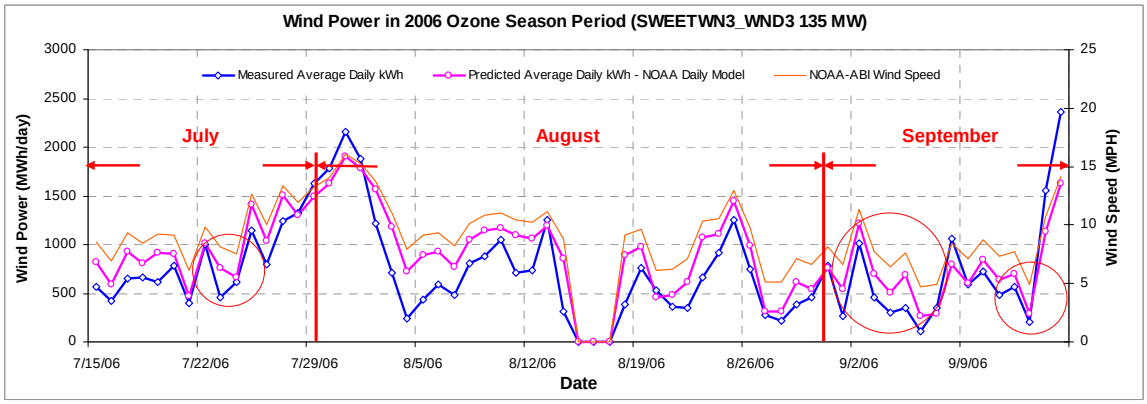


Figure 3-5: Predicted Wind Power in OSP Using NOAA Wind Speed (Using 2006 Annual Model).

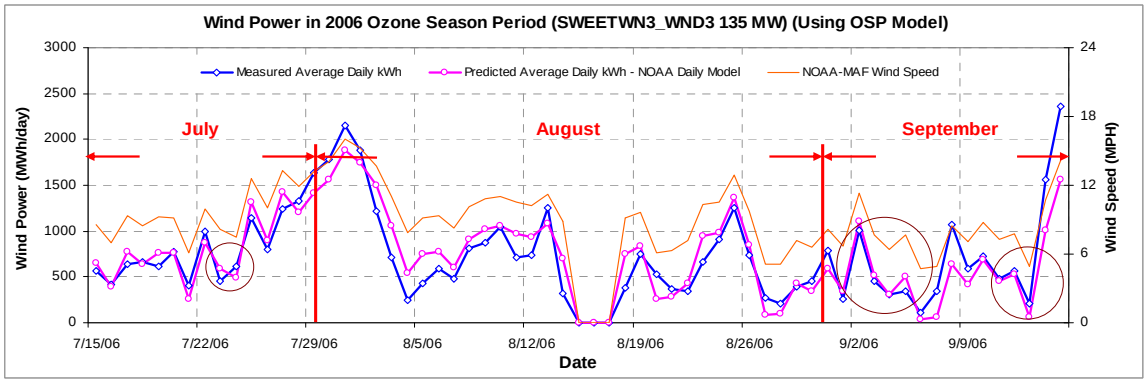


Figure 3-6: Predicted Wind Power in OSP Using NOAA Wind Speed (Using 2006 OSP Model).

Table 3-1: Comparison of Prediction Using Annual Model and OSP and NON-OSP Models.

Using OSP and NON-OSP Models:

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA
Jan-06	31	11.88	34,836	41,081	-17.93%
Feb-06	28	11.14	33,273	34,226	-2.86%
Mar-06	31	12.60	40,682	44,171	-8.57%
Apr-06	30	12.27	39,921	41,377	-3.65%
May-06	31	12.32	44,001	42,961	2.37%
Jun-06	29	9.60	26,630	29,274	-9.93%
Jul-06	31	10.15	28,497	30,786	-8.03%
Aug-06	28	9.33	19,383	21,883	-12.90%
Sep-06	30	9.46	29,729	26,337	11.41%
Oct-06	31	10.68	38,728	35,943	7.19%
Nov-06	29	10.95	42,613	34,676	18.63%
Dec-06	27	11.12	37,359	32,938	11.83%
Total	356		415,652	415,652	0.00%
Total in OSP (07/15-09/15)	60	9.24	46,015	46,015	0.00%

Using Annual Model:

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA
Jan-06	31	11.88	34,836	40,256	-15.56%
Feb-06	28	11.14	33,273	33,347	-0.22%
Mar-06	31	12.60	40,682	43,489	-6.90%
Apr-06	30	12.27	39,921	40,654	-1.84%
May-06	31	12.32	44,001	42,223	4.04%
Jun-06	29	9.60	26,630	28,077	-5.43%
Jul-06	31	10.15	28,497	32,463	-13.92%
Aug-06	28	9.33	19,383	26,004	-34.16%
Sep-06	30	9.46	29,729	28,441	4.33%
Oct-06	31	10.68	38,728	34,880	9.94%
Nov-06	29	10.95	42,613	33,730	20.85%
Dec-06	27	11.12	37,359	32,087	14.11%
Total	356	10.98	415,652	415,652	0.00%
Total in OSP (07/15-09/15)	60	4.09	46,015	54,941	-19.40%

3.3 Analysis of the Sweetwater-I Wind Farm Using OSP and NON-OSP Methods

In this section, the Sweetwater I wind farm was used as an example to further analyze the applicability of the improved procedure of modeling wind power production using the 2006 measured wind power data and NOAA wind data, and forecasting the electricity power to the selected base year, 1999. Sweetwater I was completed and commenced operation in late December 2003. It is a 37.5-megawatt project using 25 GE Wind turbines located in Nolan County, Texas.

3.3.1 Weather Data, Abilene NOAA Site

In Figure 3-7, the hourly wind speed data are shown from NOAA – Abilene Regional Airport (ABI)[2] for the years 1999 and 2006. Figure 3-8 shows the daily wind speed data from NOAA - ABI for the same two years. The annual average daily wind speed of 1999 and 2006 are 11.3 mph and 10.95 mph, respectively. To differentiate the data used for the OSP and NON-OSP models, two different colors were used in these plots.

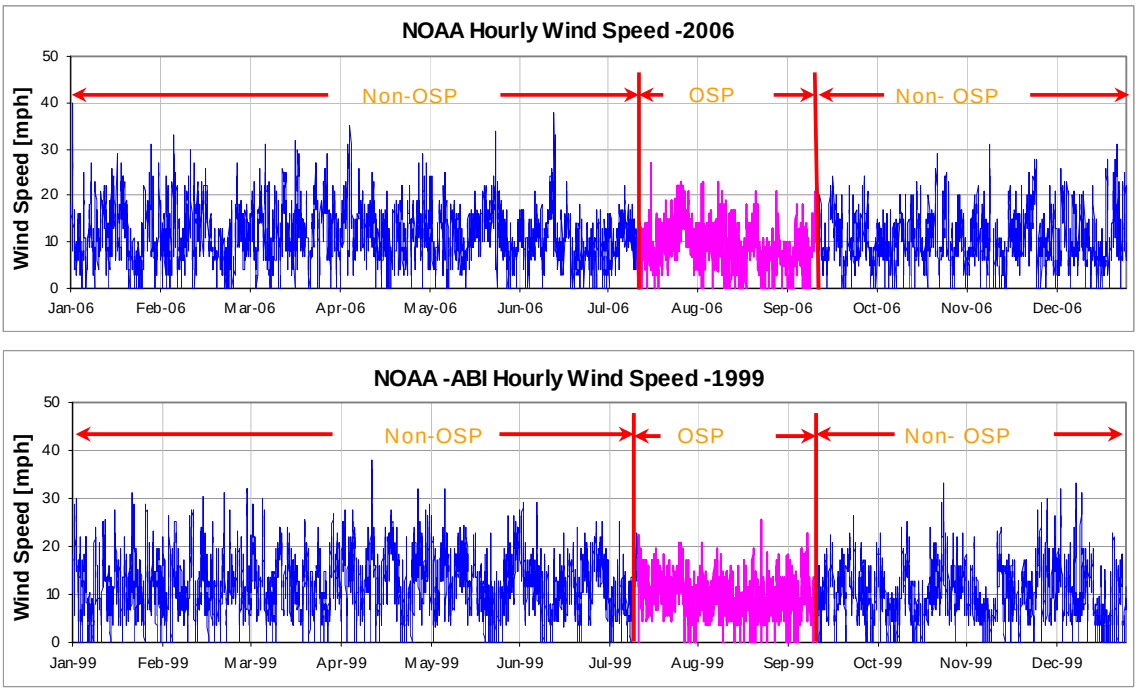
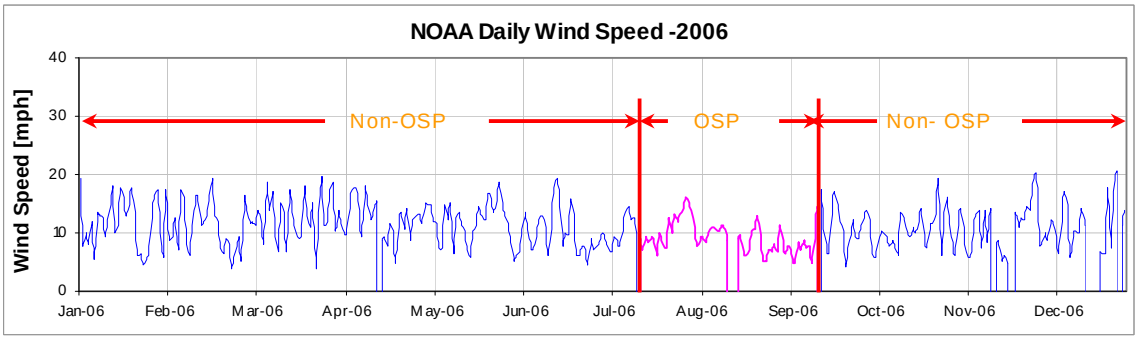


Figure 3-7: Hourly NOAA-ABI Wind Speed (1999 and 2006).



[2] NOAA wind measurements were taken at a height of 33 ft.

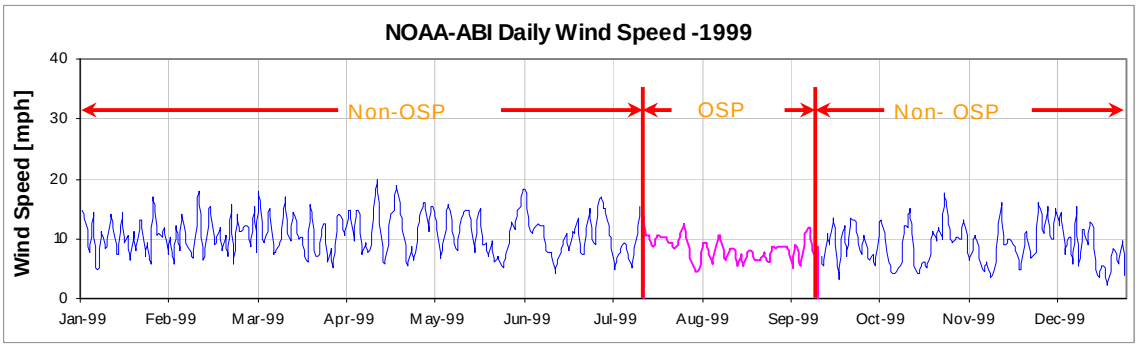


Figure 3-8: Daily NOAA-ABI Wind Speed (1999 and 2006).

3.3.2 Wind Power Data

In Figure 3-9, the hourly electricity produced and measured by ERCOT in the Ozone Season Days and the rest of the year from this wind farm is shown in time series for 2006. Figure 3-10 shows the daily turbine power generation summed from the hourly data. In Figure 3-11, the hourly wind power data were plotted against hourly NOAA wind measurements. The data show scatter and discretization (i.e., patterning) due to the precision of the measurements. In Figure 3-12, the hourly electricity produced by the wind farm except for Ozone Season Days were summed to daily totals and plotted against the daily average wind speed. Figure 3-13 shows the daily electricity produced by the wind farm plotted against the daily average wind speed only for the Ozone Season Days. These figures also show that daily wind power data are suitable for modeling purposes.

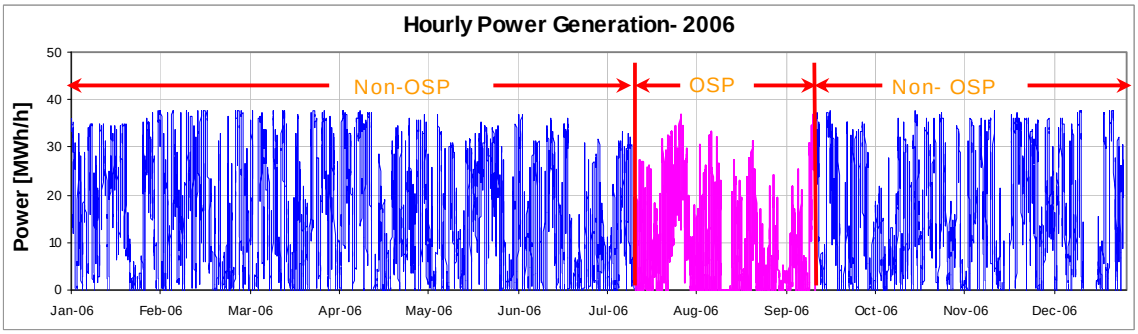


Figure 3-9: Measured Hourly Wind Power (2006), Sweetwater I Wind Farm.

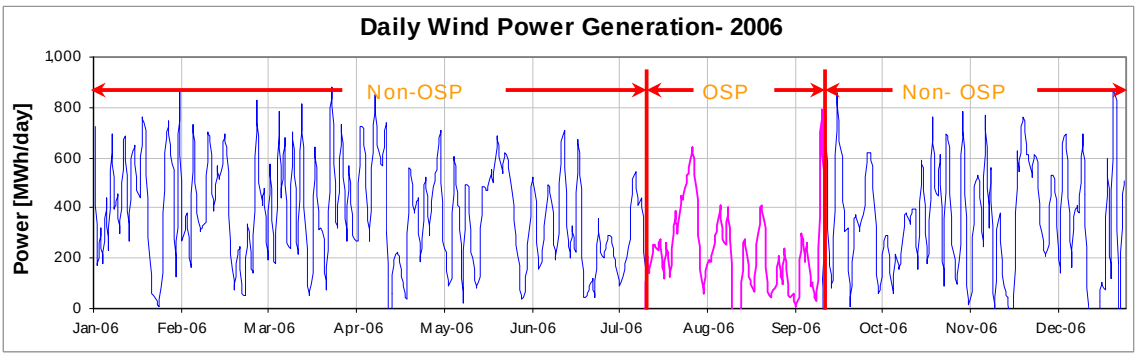


Figure 3-10: Measured Daily Wind Power (2006), Sweetwater I Wind Farm.

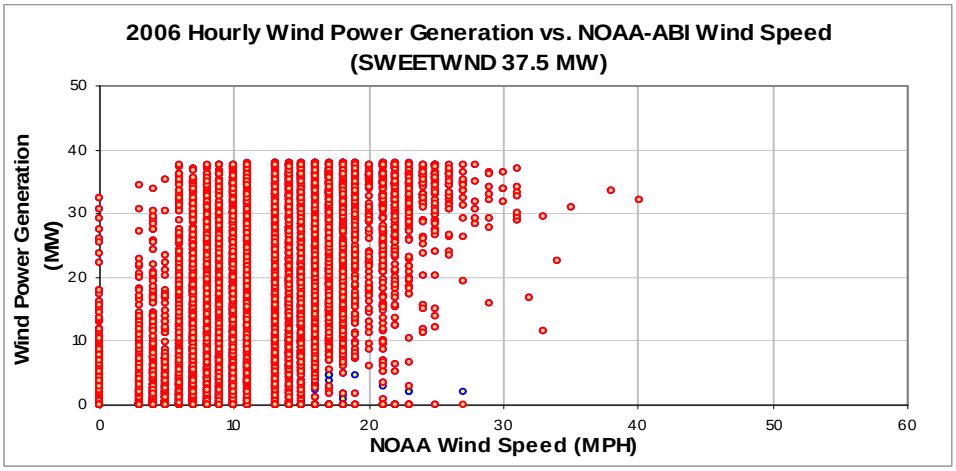


Figure 3-11: Hourly Wind Power vs. NOAA-ABI Wind Speed (2006).

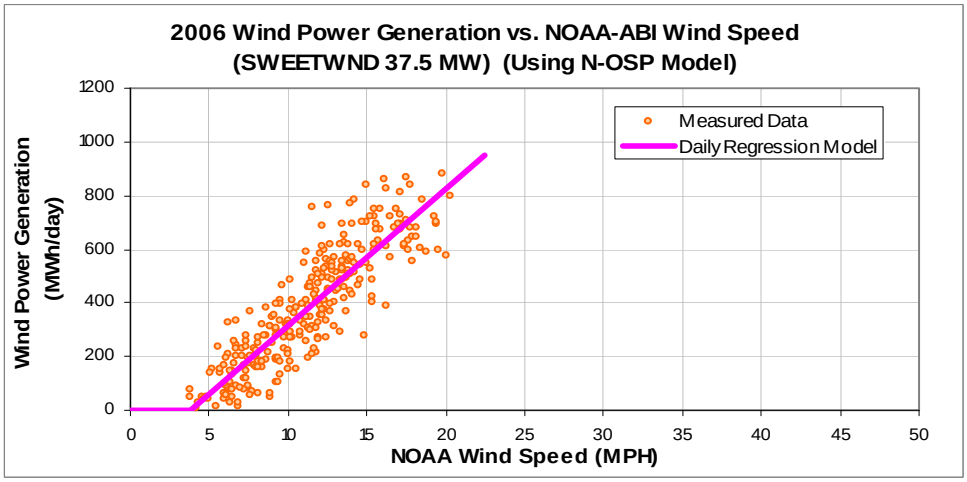


Figure 3-12: Daily Wind Power vs. NOAA-ABI Wind Speed for the Non-OSD Period.

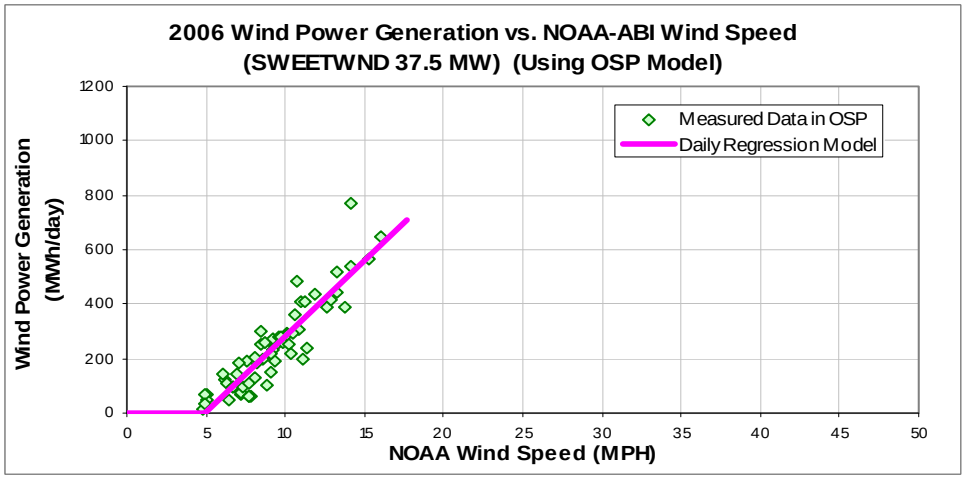


Figure 3-13: Daily Wind Power vs. NOAA-ABI Wind Speed (2006) for the OSD Period.

3.3.3 Modeling of Turbine Power vs. Wind Speed

As shown in the previous sections, daily wind power and daily NOAA wind data are more appropriate for modeling base-year power production than hourly values. Figure 3-12 and Figure 3-13 show the application of a three-parameter change-point linear regression to the average daily wind power output versus average daily NOAA wind speeds for Non-OSD and OSD periods. The summary of the regression model coefficients from the NON-OSP and OSP daily models are listed in Table 3-2 and Table 3-3. These coefficients show that these two daily models are well described with root-mean-squared error (RMSE) of 104.24 MWh/day (Non-OSP Model) and 69.4526 MWh/day (OSP model) for the 2006 data.

In Table 3-4 the predicted monthly electricity production using the 3-parameter, change-point linear daily NON-OSP and OSP models is shown for 2006 to compare against the measured monthly electricity for the same period. The biggest discrepancy of 11.42% between the measured and predicted value happened in November. Figure 3-14 shows the predicted electricity production from the wind farm as a time-series trace for the Ozone Season Period (July 15 to September 15), using the OSP daily model. For most of days, the predicted power production matches very well the measured values, demonstrating a good performance of this OSP model.

Table 3-2: Non-OSP Model Coefficients.

IMT Coefficients	NOAA NON-OSP Daily Model
Ycp (MWh/day)	-191.15
Left Slope (MWh/mph-day)	50.87
RMSE (MWh/day)	104.24
R2	0.77
CV-RMSE	27.12%

Table 3-3: OSP Model Coefficients.

IMT Coefficients	NOAA OSP Daily Model
Ycp (MWh/day)	-272.0612
Left Slope (MWh/ mph-day)	55.6220
RMSE (MWh/day)	69.4526
R2	0.8240
CV-RMSE	28.7%

Table 3-4: Predicted Wind Power Using OSP and NON-OSP Daily Models.

Month	No. Of Days	Average Daily Wind Speed (MPH)	Measured Power Generation (MWh)	Predicted Power Generation Using Daily Model (MWh)	Diff.	CV-RMSE
Jan-06	31	11.88	13,257	12,809	3.38%	21.29%
Feb-06	28	11.14	10,678	10,512	1.55%	26.75%
Mar-06	31	12.60	12,929	13,943	-7.84%	28.89%
Apr-06	29	12.19	12,045	12,437	-3.26%	27.47%
May-06	30	12.32	12,444	13,499	-8.48%	25.83%
Jun-06	30	9.83	8,793	9,260	-5.31%	26.02%
Jul-06	31	10.15	9,338	9,530	-2.06%	16.31%
Aug-06	28	9.33	6,383	6,914	-8.31%	27.60%
Sep-06	30	9.46	8,668	8,065	6.95%	32.98%
Oct-06	31	10.68	11,139	10,923	1.94%	34.90%
Nov-06	27	10.79	10,896	9,652	11.42%	33.78%
Dec-06	26	11.03	10,580	9,614	9.13%	24.02%
Total	353	10.95	127,149	127,158	-0.01%	27.12%
Total in OSP (07/15-09/15)	60	9.24	14,515	14,523	-0.06%	28.7%

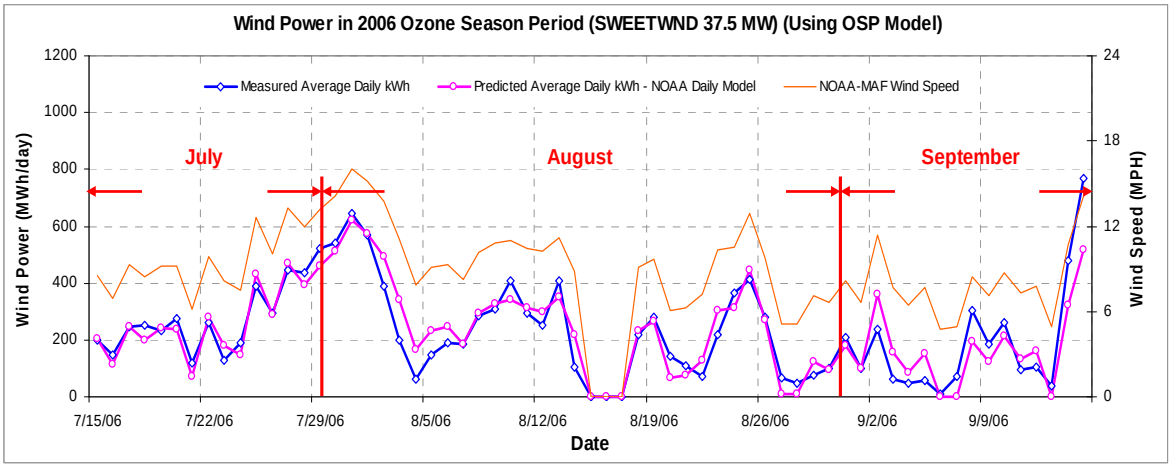


Figure 3-14: Predicted Wind Power in OSP Using NOAA-ABI Wind Speed (2006).

3.3.4 Testing of the OSP and NON-OSP Models

To test the performance of the OSP and NON-OSP daily models, the model coefficients were applied to the 2005 NOAA daily wind speed to predict the daily wind power that would have been generated in 2005. The predicted daily wind power was then summed to monthly to compare against the monthly measurements from ERCOT, as shown in Table 3-5. The test results show that both the OSP and NON-OSP models are sufficiently robust to allow for its use in projecting wind production into other weather base years with the largest observed error of 25.7% in August 2005 for using the OSD model (Figure 3-15) and the largest error of 12.7% in December 2005 for using the Non-OSP model (Figure 3-16).

Table 3-5: Predicted vs. Measured Wind Power in 2005.

Month	2005 Predicted MWh- OSP & Non-OSP Daily Models	2005 Measured-ERCOT MWh	2005 Diff. Daily Model
Jan	10384.1	11,105	6.5%
Feb	7412.4	7,130	-4.0%
Mar	12267.8	11,611	-5.7%
Apr	14054.9	13,597	-3.4%
May	11100.3	10,930	-1.6%
Jun	12361.4	13,323	7.2%
Jul	9250.0	8,465	-9.3%
Aug	5859.5	7,882	25.7%
Sep	7918.3	9,062	12.6%
Oct	8720.3	9,068	3.8%
Nov	10033.6	11,094	9.6%
Dec	9879.1	11,322	12.7%
OSD	14467.7	18,131	20.2%
Total	119,242	124,589	4.3%

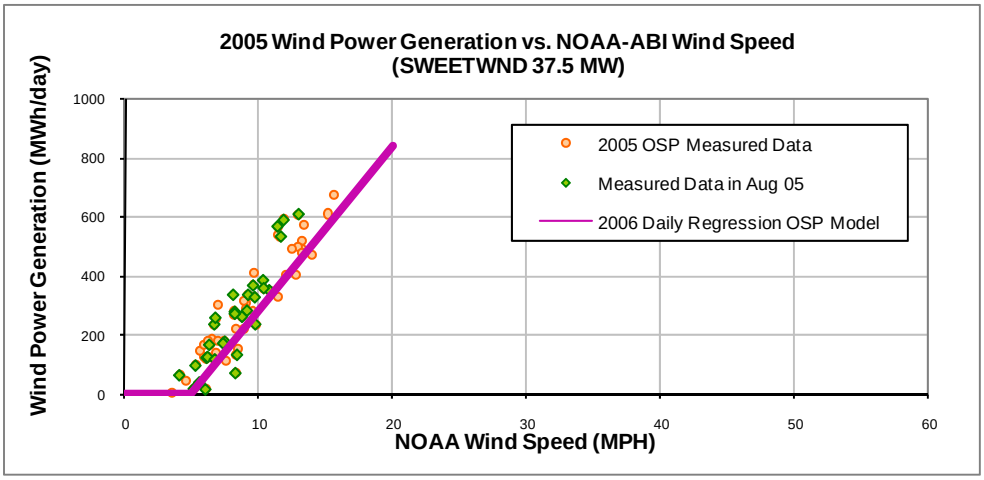


Figure 3-15: Measured and Predicted Power Production in August 2005 Using the OSP Model.

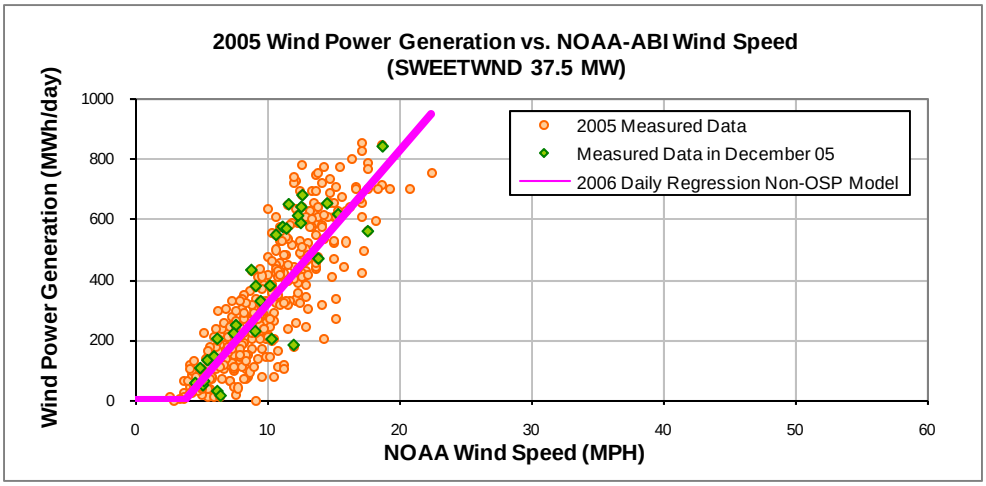


Figure 3-16: Measured and Predicted Power Production in December 2005 Using the Non-OSP Model.

3.3.5 Prediction of Wind Power in Base Year 1999

The resultant coefficients (Table 3-2 and Table 3-3) from the 3-parameter models were next applied to the 1999 average daily NOAA-ABI wind speed to predict the electricity the wind farm would have produced in 1999 (Table 3-6). In Table 3-6 the estimated annual and Ozone Season Day (OSD) values are compared against the measured 2006 values to illustrate the error that would result if one were to simply use the 2006 values without normalization. Table 3-6 shows that the estimated annual power production increased 4.8% when compared against 2006. The average daily power production during the Ozone Season Period increased 10.7% as well. This may be because 1999 (an average of 11.3 mph) is windier than 2006 (an average of 10.9 mph).

Table 3-6: Predicted Power Production in 1999.

1999 Estimated MWh/yr (2006 Daily Model)	2006 Measured MWh/yr
137,761	131,472
1999 OSD Estimated MWh/day (2006 Daily Model)	2006 OSD Measured MWh/day
268	242

3.4 Capacity Factor Analysis

The predicted monthly capacity factors for 2006 using the daily model and the measured monthly capacity factors for the same period are shown in Figure 3-17. Figure 3-18 shows the predicted capacity factors using the NOAA model from January to December for the periods 1999 through 2006, as well as the measured monthly capacity factor in 2006 and the average monthly capacity factors for these eight years, using the daily NOAA model. In Figure 3-17, the model shows good agreement tracking the measured capacity factor. In comparison, in Figure 3-18, it can be seen that there is more variation in the year to year wind speeds than the uncertainty from the model. Figure 3-18 also shows the importance of weather

normalizing the wind speeds back to the base year. Figure 3-19 shows a close up of the wind speeds for 1999 and 2006 for four Texas stations.

As seen in Table 3-7, if predicted with the NOAA daily model, the annual capacity factors for these years vary from 36.4% to 43% with an average of 39.8%. Analysis also shows that the highest electricity production occurs in the spring months (Figure 3-18). It is interesting to note that the variation across the same month of these years can be more than 20% due to the significantly different wind conditions, e.g. March and May.

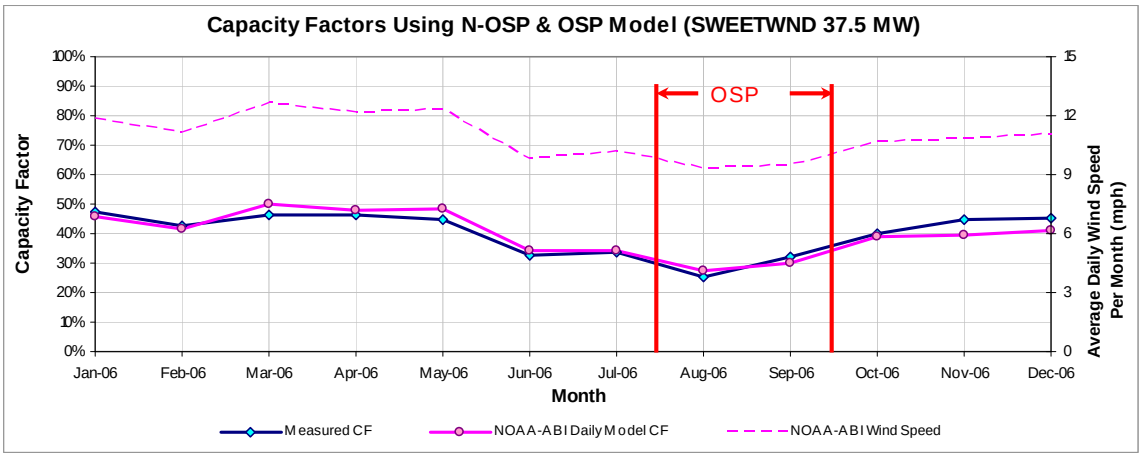


Figure 3-17: Predicted Capacity Factors Using Daily Models (2006).

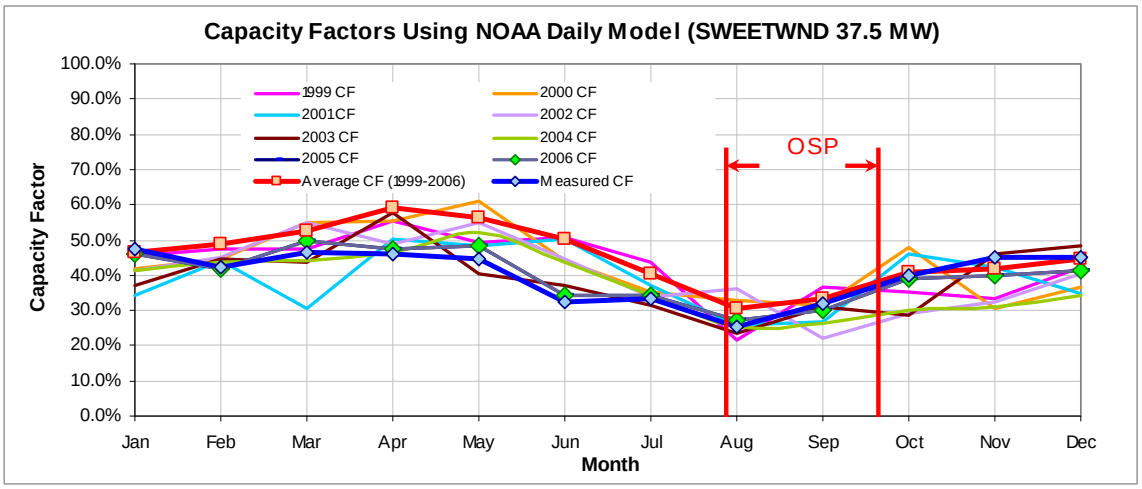


Figure 3-18: Predicted Capacity Factors Using Daily Models (1999-2006).

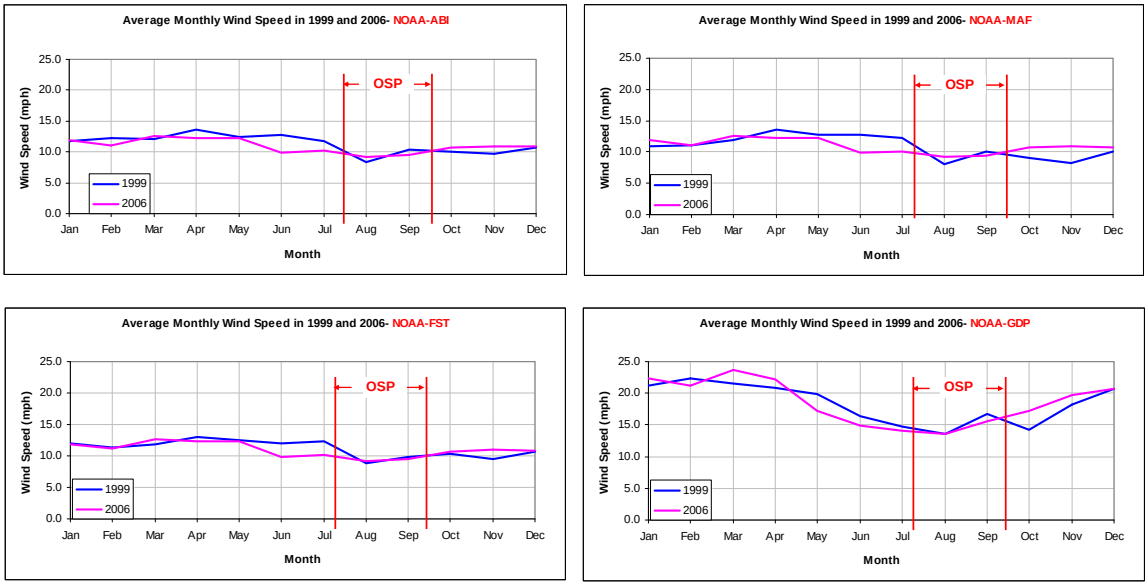


Figure 3-19: 1999 and 2006 Monthly Average Wind Speed for Four NOAA Weather Stations.

Table 3-7: Summary of Predicted Capacity Factors (1999-2006).

	NOAA Annual Average Wind Speed (MPH)	Annual Predicted Capacity Factor - NOAA Daily Model	Predicted Capacity Factor in OSP – NOAA Daily Model
1999	11.3	42.3%	29.8%
2000	11.5	43.0%	28.9%
2001	10.8	39.3%	28.1%
2002	11.0	40.3%	28.2%
2003	10.8	39.0%	28.0%
2004	10.7	37.8%	28.5%
2005	10.3	36.4%	28.8%
2006	11.0	39.9%	28.5%
Average (1999-2006)	10.9	39.8%	28.6%

3.5 Summary of Wind Power Production for All Wind Farms in the Texas ERCOT Region

Table 3-8 shows the summary of the 2006 measured power production for the wind farms that were operating in 2006 in the Texas ERCOT region and the estimated 1999 power production using daily regression models (Appendix B). Table 3-9 shows the monthly average wind speed across four weather stations used in the modeling. As shown in Figure 3-20 and Figure 3-21, the estimated power production in 1999 (6,919,353 MWh/yr) increased about 2% when compared to what was measured in 2006 (6,760,687 MWh/yr). For the Ozone Season Period, the estimated average daily power production is 15,468 MWh/day, a 15% increase from that measured in 2006 (13,488 MWh/day). This is because for all the four NOAA weather stations involved in the modeling, 1999 is windier than 2006 (Table 3-9 and Figure 3-19).

Figure 3-22 presents the comparison of the 2006 measured annual power production against the 1999 estimated annual power production for each wind farm. Figure 3-23 shows the difference between the 2006 measured average daily power production and the 1999 estimated average daily power production during the Ozone Season Period for each wind farm. For the wind farms Horse Hollow 2, 3 and 4 and Red Canyon, which started operation in the mid of 2006, the power production during the testing period (mostly from January to June 2006) was low and was excluded in the analysis. Therefore, only certain months of data were used in the modeling. For Brazos Wind Ranch and Red Canyon Wind Farm, it shows that measured power in 2006 was much higher than the estimated power production in 1999. This is because some metering problems were identified from the ERCOT measured data during the analysis, which resulted in almost doubled maximum capacity in certain months (Figure 3-24). Those data were excluded in the analysis for the modeling purpose but were still included in the total measured MWh from ERCOT before confirmation from ERCOT about the possible metering problem is received. This may also explain why the difference between 1999 estimated MWh and 2006 measured MWh is much smaller (2%) for annual totals than the OSD period (15%).

From this analysis it can be concluded that the use of improved weather normalization procedure for predicting 1999 base year production based on 2006 measured power production is more accurate than simply using the measured 2006 power production as the base year power production. Therefore, it is recommended to the TCEQ that the current discount factor be reduced to take the more accurate modeling into account.

Table 3-10 shows the summary of predicted wind power production in other years (i.e., 2000 and 2002) for all the wind farms in the ERCOT region, using the coefficients from the daily models developed using 2006 measured wind power data and NOAA wind speed data in 2000 and 2002.

Table 3-8: Summary of Power Production for All Wind Farms.

Wind Unit Name	County	NOAA Weather Station	PCA	Capacity (MW)	2006 Measured (MWh/yr) (ERCOT Original Data)	1999 Estimated Using Daily Model (MWh/yr)	2006 OSP Measured (MWh/day)	1999 OSP Estimated (MWh/day)
BRAZ_WND_WND1	SCURRY	ABI	AEP-West	99	423,823	348,113	566	637
BRAZ_WND_WND2	SCURRY	ABI	AEP-West	61	249,970	198,702	331	371
BUFFALO_GAP_1	TAYLOR	ABI	AEP-West	120	372,954	390,430	719	813
CALLAHAN_WND1	TAYLOR	ABI	AEP-West	114	410,497	428,993	789	885
*DELAWARE_WIND_NWP**	*CULBERSON*	*GDP*	*TXU*	*30*	*67,288*	*67,452*	*97*	*93*
H_HOLLOW_WND1	TAYLOR	ABI	AEP-West	213	684,543	728,851	1,211	1,363
HHOLLOW2_WIND1**	TAYLOR	ABI	AEP-West	224	191,471	198,696	626	1,029
HHOLLOW3_WND_1**	TAYLOR	ABI	AEP-West	299	338,374	351,472	1,116	1,246
HHOLLOW4_WND_1**	TAYLOR	ABI	AEP-West	115	165,572	195,070	583	657
INDNENR_INDNENR	PECOS	FST	AEP-West	80	257,297	270,994	506	595
INDNENR_INDNENR_2	PECOS	FST	AEP-West	80	230,780	246,042	455	537
*INDNNWP_INDNNWP**	*PECOS*	*FST*	*AEP-West*	*82.5*	*235,758*	*251,397*	*487*	*569*
KING_NE_KINGNE	UPTON	MAF	AEP-West	79.3	186,937	201,259	322	365
KING_NW_KINGNW	UPTON	MAF	AEP-West	79.3	217,652	231,449	408	455
KING_SE_KINGSE	UPTON	MAF	AEP-West	40.3	91,151	98,462	161	184
KING_SW_KINGSW	UPTON	MAF	AEP-West	79.3	196,732	210,137	369	415
*KUNITZ_WIND_LGE**	*CULBERSON*	*GDP*	*LCRA*	*35*	*57,562*	*57,072*	*64*	*61*
RDCANYON_RDCNY1**	BORDEN	ABI	AEP-West	124	323,018	250,818	787	787
*SGMTN_SIGNALMT**	*HOWARD*	*MAF*	*TXU*	*41*	*101,218*	*106,777*	*178*	*198*
*SW_MESA_SW_MESA**	*UPTON*	*MAF*	*AEP-West*	*75*	*210,316*	*224,262*	*424*	*476*
SWEETWN2_WND2	NOLAN	ABI	LCRA	92	332,222	354,718	606	669
SWEETWN3_WND3	NOLAN	ABI	LCRA	135	416,803	442,506	767	843
SWEETWND_WND1	NOLAN	ABI	LCRA	37.5	126,379	137,761	242	268
TRENT_TRENT	NOLAN	ABI	TXU	150	508,398	534,218	933	1,054
*WOODWRD1_WOODWRD1**	*PECOS*	*FST*	*AEP-West*	*80*	*185,586*	*200,746*	*379*	*459*
*WOODWRD2_WOODWRD2**	*PECOS*	*FST*	*AEP-West*	*80*	*178,385*	*192,956*	*362*	*439*
TOTAL				2,645	6,760,687	6,919,353	13,488	15,468

*** Wind farms in Italic were built before 9/2001.**

**** Only certain months of data available for modeling**

Table 3-9: Summary of 1999 and 2006 Monthly Average Wind Speed for Four NOAA Weather Stations.

Month	Wind Speed ABI (mph)		Wind Speed MAF (mph)		Wind Speed FST (mph)		Wind Speed GDP (mph)	
	1999	2006	1999	2006	1999	2006	1999	2006
Jan	11.8	11.9	10.9	10.6	12.0	11.1	21.2	22.4
Feb	12.2	11.1	11.2	9.9	11.4	10.2	22.4	21.2
Mar	12.1	12.6	11.8	11.9	11.8	11.7	21.5	23.7
Apr	13.6	12.3	13.5	12.2	13.1	12.1	20.9	22.2
May	12.4	12.3	12.8	12.0	12.6	12.3	19.9	17.1
Jun	12.7	9.8	12.8	10.7	12.0	10.9	16.3	14.8
Jul	11.7	10.1	12.3	10.3	12.3	10.6	14.8	14.1
Aug	8.4	9.2	8.0	8.4	8.8	8.9	13.5	13.6
Sep	10.4	9.5	10.1	9.6	9.9	9.5	16.8	15.5
Oct	10	10.7	9.1	10.0	10.4	10.5	14.2	17.1
Nov	9.7	10.9	8.3	9.8	9.5	11.0	18.2	19.7
Dec	10.7	10.8	10.0	9.5	10.6	10.4	20.6	20.8
Annual Average	11.3	10.9	10.9	10.4	11.2	10.8	18.3	18.5
OSP Average	9.7	9.2	9.5	8.9	10.0	9.2	13.9	14.2

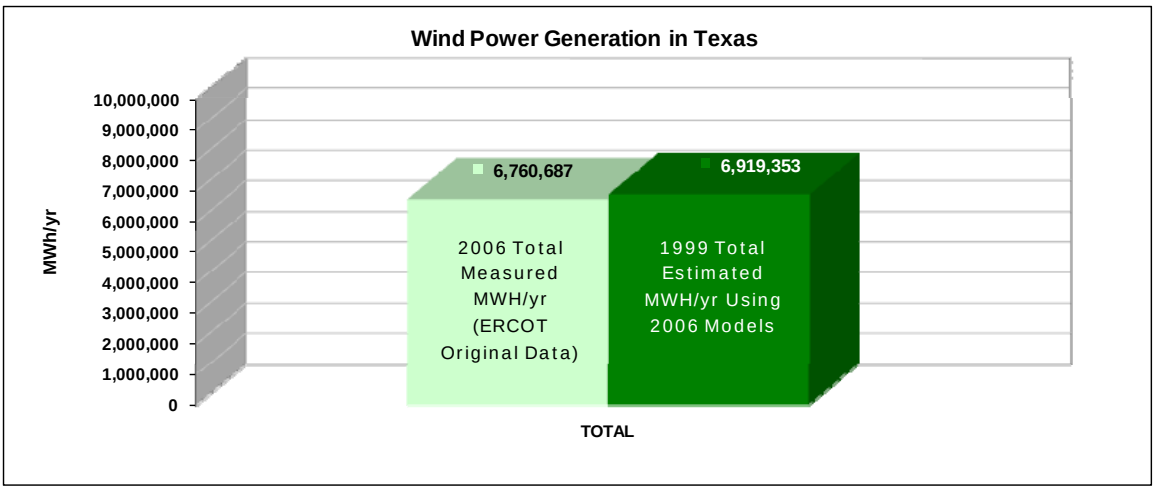


Figure 3-20: Comparison of Total 2006 Measured and 1999 Estimated Power Production.

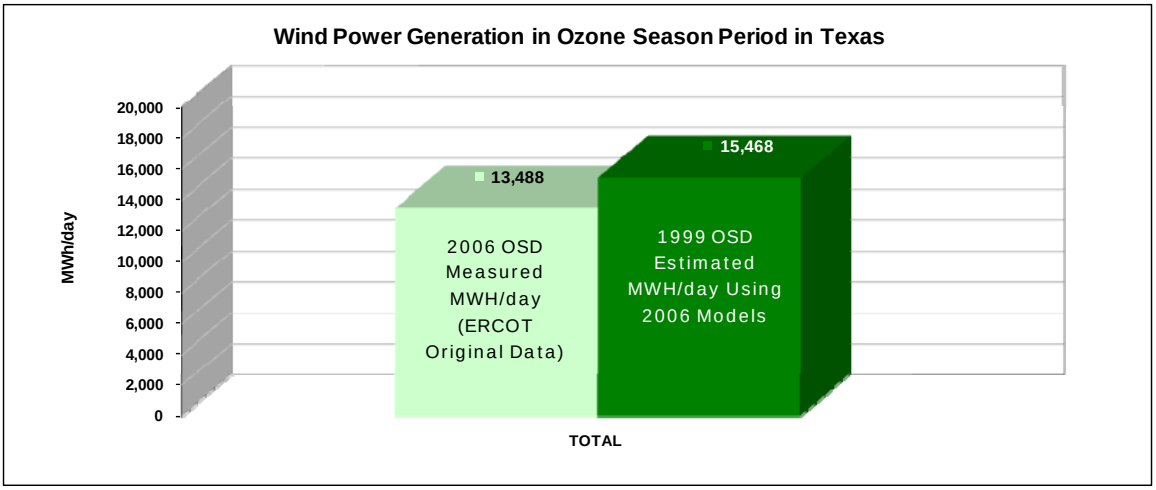


Figure 3-21: Comparison of Total 2006 OSD Measured and 1999 OSD Estimated Power Production.

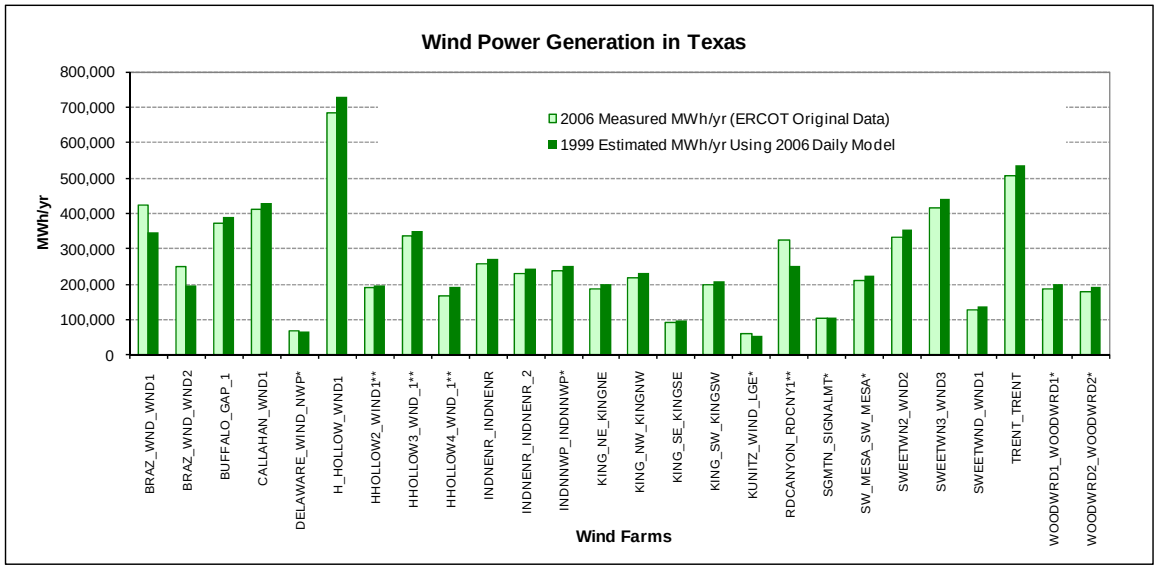


Figure 3-22: Comparison of 2006 Measured and 1999 Estimated Power Production for Each Wind Farm.

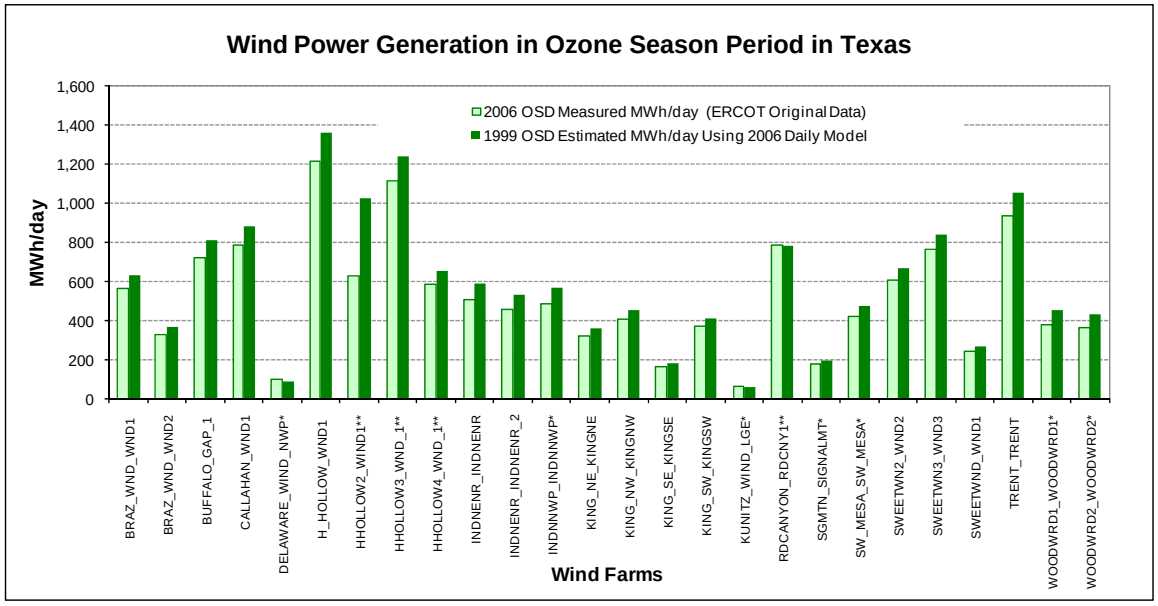


Figure 3-23: Comparison of 2006 OSD Measured and 1999 OSD Estimated Power Production for Each Wind Farm.

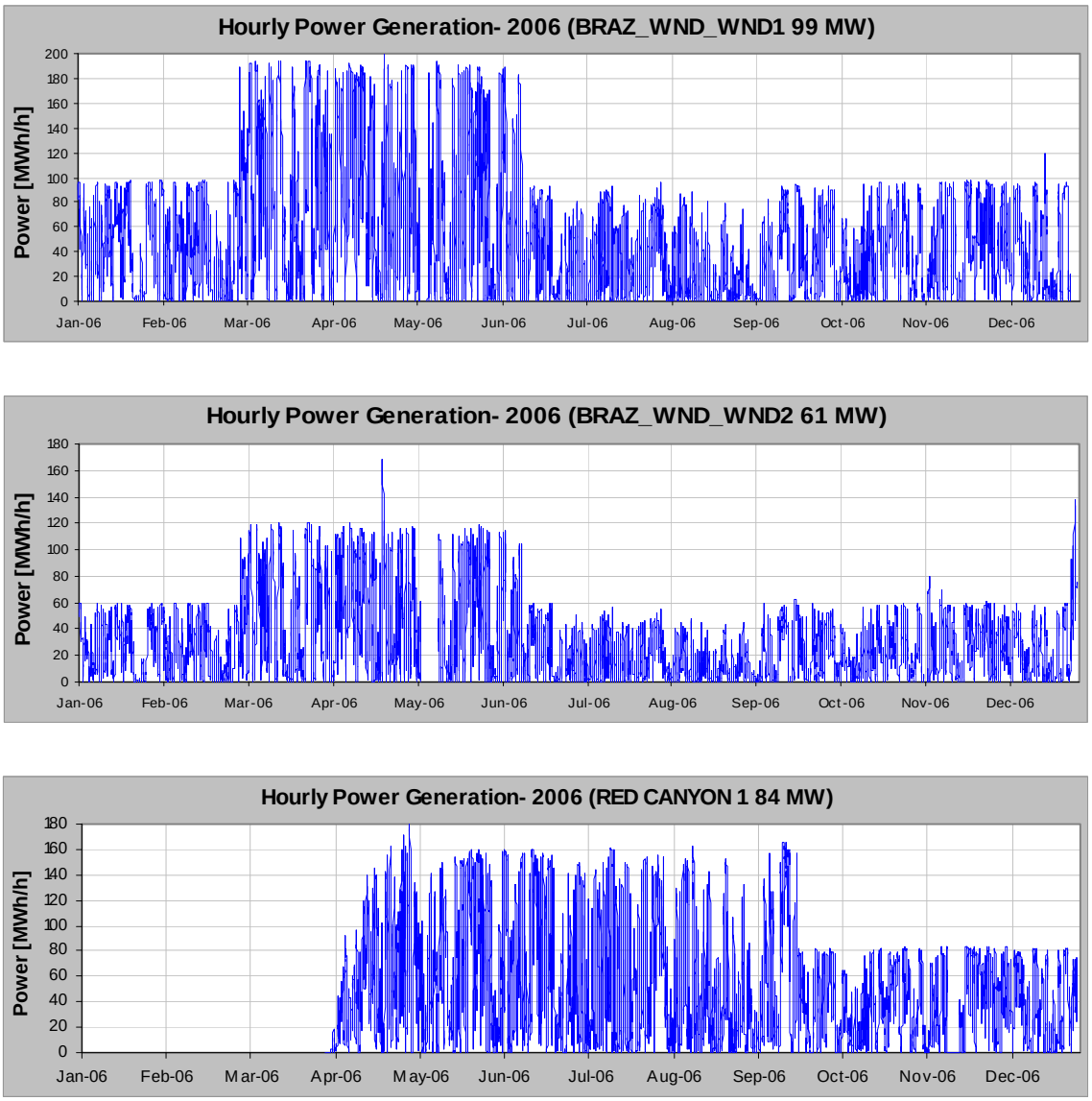


Figure 3-24: Data Metering Problem Identified in Brazos Wind Branch and Red Canyon Wind Farm.

Table 3-10: Summary of Predicted Wind Power in Base Years (1999, 2000 and 2002) for All Wind Farms in the ERCOT Region.

Wind Unit Name	County	NOAA Weather Station	Capacity (MW)	PCA	Predicted Wind Power in 1999		Predicted Wind Power in 2000		Predicted Wind Power in 2002	
					Annual (MWh/yr)	OSD (MWh/day)	Annual (MWh/yr)	OSD (MWh/day)	Annual (MWh/yr)	OSD (MWh/day)
BRAZ_WND_WND1	SCURRY	ABI	99	AEP-West	348,113	637	357,515	661	335,262	692
BRAZ_WND_WND2	SCURRY	ABI	61	AEP-West	198,702	371	203,910	384	191,699	401
BUFFALO_GAP_1	TAYLOR	ABI	120	AEP-West	390,430	813	400,986	845	377,527	886
CALLAHAN_WND1	TAYLOR	ABI	114	AEP-West	428,993	885	440,549	916	413,873	958
DELAWARE_WIND_NWP	CULBERSON	GDP	30	TXU	67,452	93	68,157	88	69,224	100
H_HOLLOW_WND1	TAYLOR	ABI	213	AEP-West	728,851	1,363	747,753	1,413	704,333	1,479
HHOLLOW2_WIND1*	TAYLOR	ABI	224	AEP-West	198,696	828	214,437	1,071	195,265	1,020
HHOLLOW3_WND_1**	TAYLOR	ABI	299	AEP-West	351,472	1,246	351,290	1,288	327,399	1,345
HHOLLOW4_WND_1**	TAYLOR	ABI	115	AEP-West	195,070	657	195,152	682	182,972	714
INDNENR_INDNENR	PECOS	FST	80	AEP-West	270,994	595	278,616	727	275,473	721
INDNENR_INDNENR_2	PECOS	FST	80	AEP-West	246,042	537	253,006	659	250,113	653
INDNWP_INDNWP	PECOS	FST	82.5	AEP-West	251,397	569	258,332	689	255,431	684
KING_NE_KINGNE	UPTON	MAF	79.3	AEP-West	201,259	365	207,586	394	203,240	491
KING_NW_KINGNW	UPTON	MAF	79.3	AEP-West	231,449	455	237,913	487	234,583	592
KING_SE_KINGSE	UPTON	MAF	40.3	AEP-West	98,462	185	101,694	201	99,787	253
KING_SW_KINGSW	UPTON	MAF	79.3	AEP-West	210,137	415	216,345	445	213,183	547
KUNITZ_WIND_LGE	CULBERSON	GDP	35	LCRA	57,072	62	57,882	57	58,992	67
RDCANYON_RDCNY1***	BORDEN	ABI	124	AEP-West	250,818	787	256,664	804	240,144	826
SGMTN_SIGNALMT	HOWARD	MAF	41	TXU	106,777	198	109,442	211	108,301	256
SW_MESA_SW_MESA	UPTON	MAF	75	AEP-West	224,262	476	230,836	510	228,225	624
SWEETWN2_WND2	NOLAN	ABI	92	LCRA	354,718	669	364,070	693	342,272	725
SWEETWN3_WND3	NOLAN	ABI	135	LCRA	442,506	843	453,618	872	428,164	911
SWEETWND_WND1	NOLAN	ABI	37.5	LCRA	137,761	268	141,713	278	132,344	292
TRENT_TRENT	NOLAN	ABI	150	TXU	534,218	1,054	549,670	1,095	513,167	1,148
WOODWRD1_WOODWRD1	PECOS	FST	80	AEP-West	200,746	459	207,281	578	204,919	573
WOODWRD2_WOODWRD2	PECOS	FST	80	AEP-West	192,956	439	199,161	552	196,890	547
TOTAL			2,645		6,919,352	15,269	7,103,576	16,601	6,782,781	17,504

* H_HOLLOW_WND2: The annual numbers include only six months data from July to December. The turbine started operating in July 2006.
** H_HOLLOW_WND3 & H_HOLLOW_WND4: The annual numbers include only eight months data from May to December. The turbine started operating in May 2006.
*** RDCANYON: The annual numbers include only nine months data from April to December. The turbine started operating in April 2006.

3.6 Comparison of 1999 Estimated Wind Power in 2007 Report and This Report

Compared to what was reported in the 2007 annual report, an increase of 48% on predicted annual wind power in 1999 was observed, from 4,682,682 MWh/yr to 6,919,353 MWh/yr. The average daily wind power in the 1999 OSD period showed a higher increase of 61%, from 9,625 MWh/day to 15,468 MWh/day. The total wind power capacity included in this year's analysis increased from 1,627 MW to 2,645 MWh (a 63% increase), which includes 120 MW from Buffalo Gap, 224 MW from Horse Hollow 2, 299 MW from Horse Hollow 3, 115 MW from Horse Hollow 4, 124 MW from Red Canyon, and 135 MW from Sweet Water 3.

Figure 3-25 shows the annual comparison of measured wind power of 2005 and 2006 for all the wind farms. In general, the wind farms operated at the similar output level for these two years. The total annual wind power production in 2006 for most wind farms was a little higher than in 2005. This is consistent with the fact that the average annual wind speed from all four NOAA weathers stations in 2006 is a little higher than 2005 (Table 3-11). The ones showing a big difference were due to fewer operating months in 2005, e.g. Callahan, Sweetwater 2, and Horse Hollow 1 Wind Farms, which started operating in 2005. For Brazos Wind Farm, the higher production in 2006 is due to the metering problem mentioned in the previous section.

Figure 3-26 shows the comparison of measured power of 2005 and 2006 for the Ozone Season Period. It is noted that for most of the wind farms, the measured average daily wind power in 2006 OSD is lower than that of 2005, which is different than the annual trend. As shown in Table 3-13, this may be due to the

opposite wind condition difference in the OSD period. In 2006, among four NOAA weather stations, three of them are less windy than 2005 in the OSD period.

Figure 3-27 shows the annual comparison of the estimated power in 1999 using the 2005 annual model and the 2006 OSP and Non-OSP models. Except for the wind farms that have different operation months, e.g. Horse Hollow 1, the predicted wind power in 1999 using the 2005 data and model coefficients is very close to what is predicted using the 2006 data and model coefficients for the majority of the wind farms.

Figure 3-28 shows the comparison of the estimated power in 1999 using the 2005 and 2006 models for the Ozone Season Period. The new procedure of using a separate model for the OSD period improves the accuracy of the prediction of the OSD wind power and reflects more closely the operation pattern of wind farms in the summer season. Therefore, this shows that the estimated power in the 1999 OSD using the 2006 OSP model is lower than the one predicted using the 2005 annual model across all of the wind farms.

Figure 3-31 and Figure 3-30 show that, in general, the variation in the 1999 predicted wind power caused by using measured data from different years is much smaller than the difference between the 2005 and 2006 measured wind power for most of the wind farms with steady operation. This observation confirms the robust performance and importance of the weather normalization procedure. Due to the absence of detailed information on curtailment, maintenance, or other factors, the explanation on the difference in trend among individual wind farms was not included in this work.

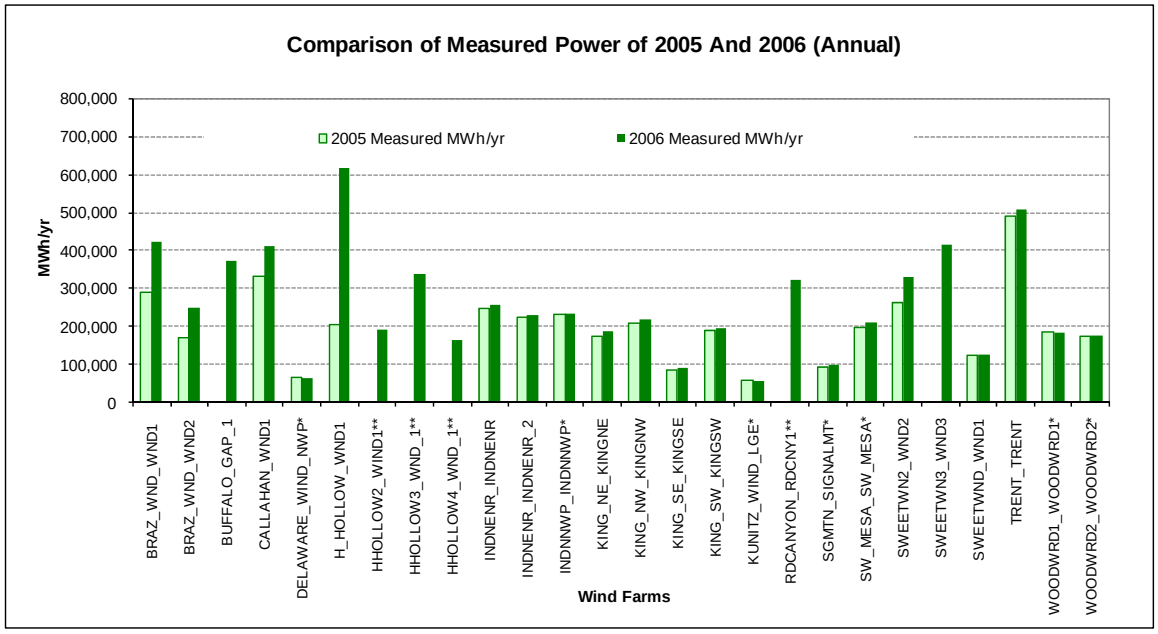


Figure 3-25: Comparison of Measured Wind Power of 2005 and 2006 (Annual).

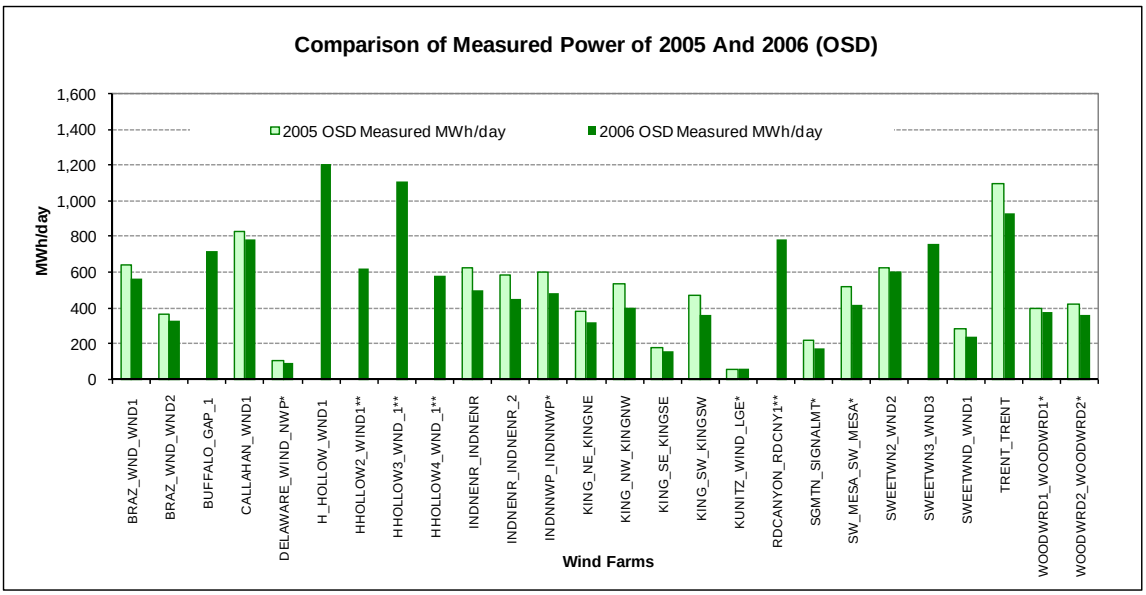


Figure 3-26: Comparison of Measured Wind Power of 2005 and 2006 (OSD).

Table 3-11: Comparison of Wind Speed of 2005 and 2006.

Month	Wind Speed ABI (mph)		Wind Speed MAF (mph)		Wind Speed FST (mph)		Wind Speed GDP (mph)	
	2005	2006	2005	2006	2005	2006	2005	2006
Jan	10.3	11.9	9.7	10.6	10.2	11.1	19.1	22.4
Feb	8.9	11.1	8.9	9.9	9.2	10.2	21.5	21.2
Mar	11.5	12.6	11.1	11.9	11.1	11.7	22.3	23.7
Apr	13	12.3	12.1	12.2	12.5	12.1	19.9	22.2
May	11	12.3	10.8	12.0	11.7	12.3	17.3	17.1
Jun	11.9	9.8	12.1	10.7	12.4	10.9	15.7	14.8
Jul	9.9	10.1	10.4	10.3	10.6	10.6	16.0	14.1
Aug	8.3	9.2	9.2	8.4	8.5	8.9	12.9	13.6
Sep	9.3	9.5	9.7	9.6	9.2	9.5	14.5	15.5
Oct	9.3	10.7	9.3	10.0	9.7	10.5	16.8	17.1
Nov	10.3	10.9	9.4	9.8	10.3	11.0	19.8	19.7
Dec	10	10.8	9.5	9.5	8.6	10.4	19.5	20.8
Annual Average	10.3	10.9	10.2	10.4	10.3	10.8	18.0	18.5
OSP Average	9.0	9.2	9.7	8.9	9.3	9.2	14.5	14.2

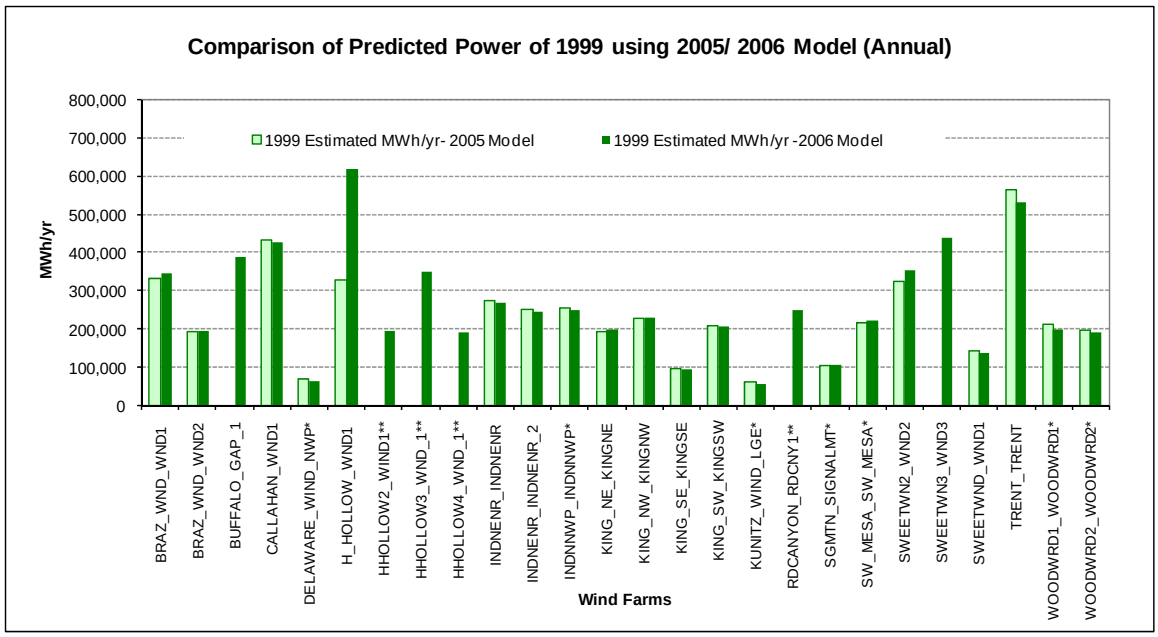


Figure 3-27: Comparison of Estimated Power of 1999 using the 2005 and 2006 Model (Annual).

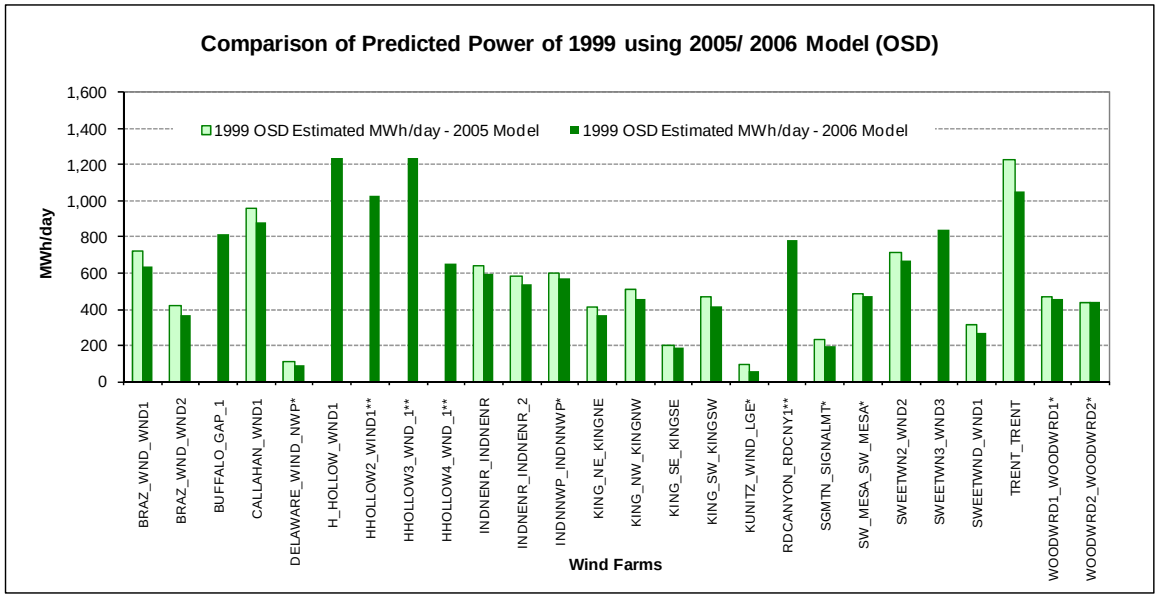


Figure 3-28: Comparison of estimated power of 1999 using the 2005 and 2006 model (OSD).

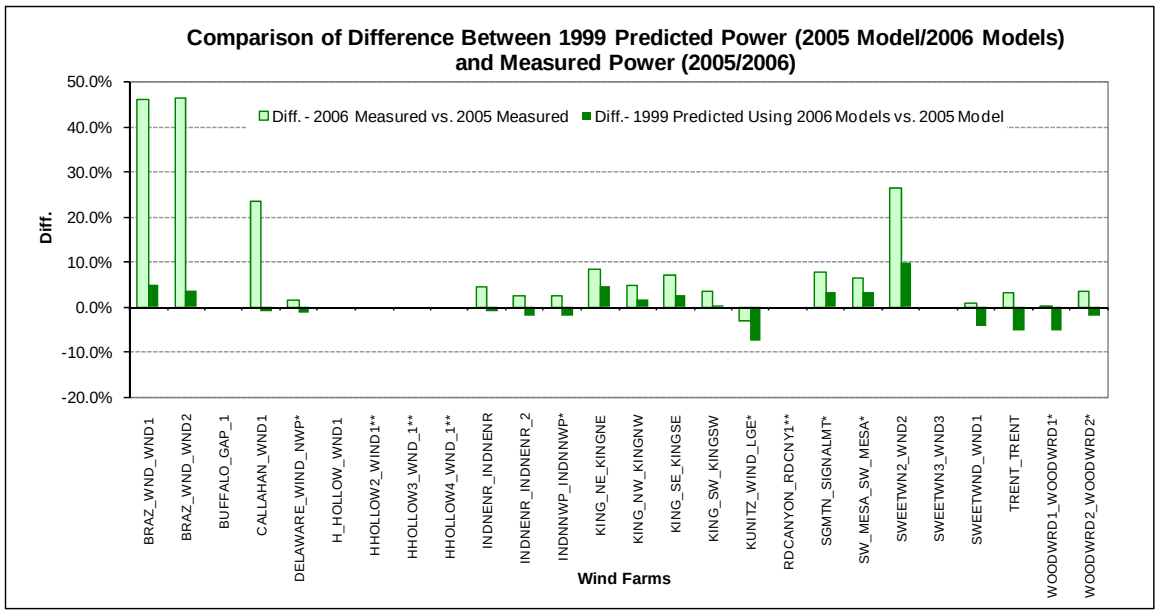


Figure 3-29: Comparison of Difference between 1999 Predicted Power and 2005/2006 Measured Power.

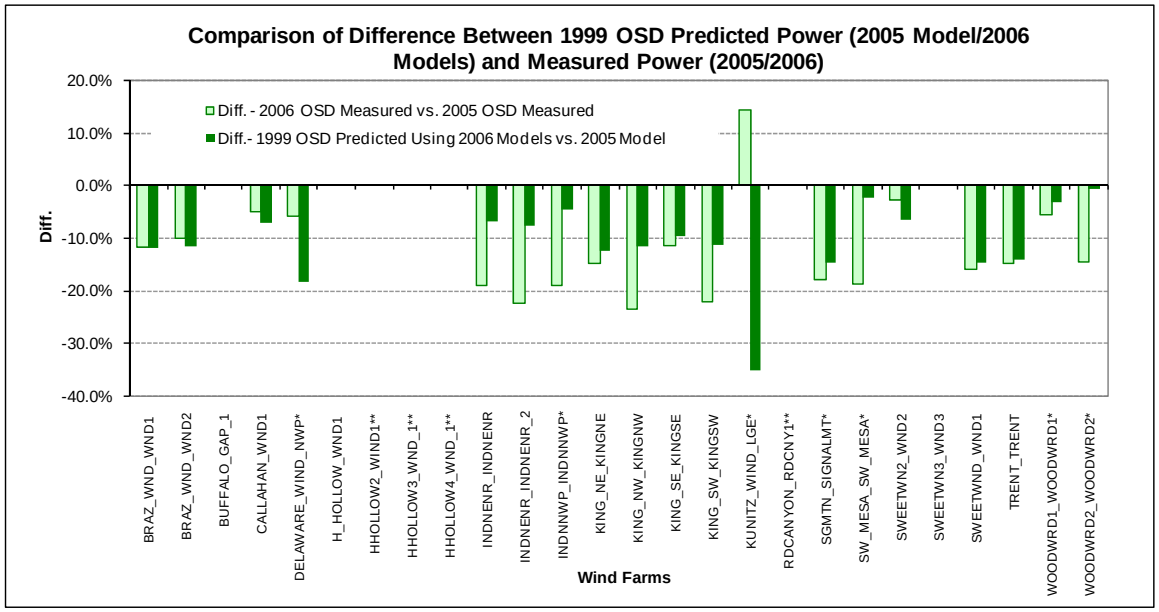


Figure 3-30: Comparison of Difference between 1999 OSD Predicted Power and 2005/2006 OSD Measured Power.

3.7 Uncertainty Analysis on the 2006 Daily Regression Models

One of the advantages of using regression models is that it allows for an uncertainty analysis to be calculated, which can be used to assess the accuracy of the model. This section of the report presents an updated uncertainty analysis for the daily regressions that were applied to the 2006 data.

Assuming that the daily energy production of a wind farm data can be related linearly with the daily average wind speed (see Figure 3-31) and expressed as

$$\hat{E}_i = c_o + c_1 V_i \qquad (1)$$

Where V is the daily average wind speed, $\hat{E}$ is the daily total energy production, and c_o and c_1 are the resultant coefficients of a linear regression. The subscript i presents any day over the modeling period.

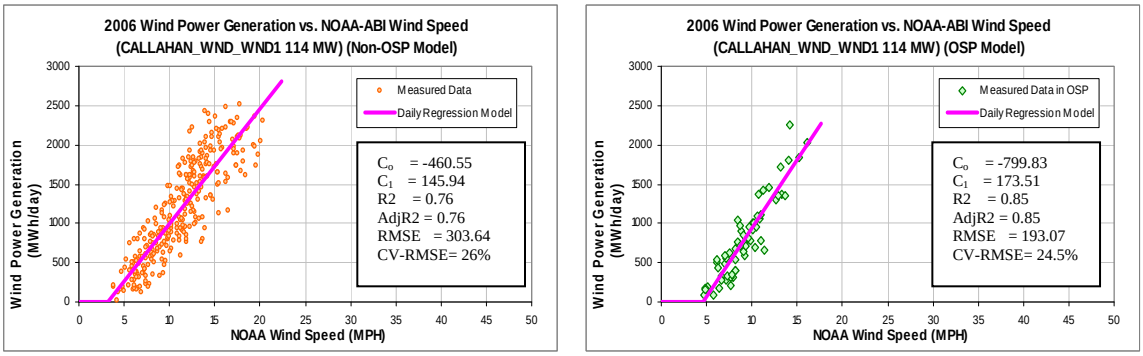


Figure 3-31: Linear Model Presentation of the Daily Wind Power Generation on the Year 2006 for Callahan Wind Farm.

The primary purpose of modeling in this analysis is to back-cast the wind power production, or predict the power production in another weather year that would have occurred if the turbines had been installed and operating. This allows for the evaluation of the NOx reductions during the base-year weather conditions. Unfortunately, any prediction intrinsically contains an uncertainty, which is related to the prediction variance. Thus, the prediction uncertainty, $\sigma^2\left(\hat{E}_{pred,j}\right)$, assuming no autocorrelation effects in the data used to generate the linear model, can be presented for a particular observation, j, during any time at a particular condition is presented as follows:

$$\sigma^2\left(\hat{E}_{pred,j}\right) = MSE\left(\hat{E}_i\right)\cdot\left[1+\frac{1}{n}+\frac{\left(V_j-\overline{V}_n\right)^2}{\sum_{i=1}^{n}\left(V_i-\overline{V}_n\right)^2}\right] \qquad (2)$$

The mean square error, $MSE\left(\hat{E}_i\right)$, during the period of the development of the linear model can be computed by

$$MSE\left(\hat{E}_i\right) = \left[\frac{1}{n-(k+1)}\right]\sum_{i=1}^{n}\left(E_i-\hat{E}_i\right)^2 \qquad (3)$$

Where *n* is the number of days in the period used for the developed model, *k* is the number of regressor variables in the linear model, and $\overline{V_n}$ is the mean value of the velocity on the modeling period.

The last term in the brackets of the equation 2 accounts for the increase in the variance of the energy prediction for any particular observation, *j*, which is different from the centroid of the modeling data. On the other hand, the second term accounts for the variance in predicting the mean energy predicted for the observation, *j*.

The total uncertainty for a period of interest, of *m* days, is then the sum of all the wind energy predicted $\hat{E}_{pred,j}$ in each individual observation.

Assuming that

$$\sum_{j=1}^{m}\sigma^2\left(\hat{E}_{pred,j}\right)=\sigma^2\left(\sum_{j=1}^{m}\left(\hat{E}_{pred,j}\right)\right)=\sigma^2\left(\hat{E}_{pred,total}\right) \quad (4)$$

and the total prediction variance or uncertainty is obtained through

$$\sigma^2\left(\hat{E}_{pred,total}\right)=MSE\left(\hat{E}_i\right)\cdot m\cdot\left[1+\frac{1}{n}+\frac{\sum_{j=1}^{m}\left(V_j-\overline{V_n}\right)^2}{m\sum_{i=1}^{n}\left(V_i-\overline{V_n}\right)^2}\right] \quad (5)$$

Thus, it is observable that the last equation is affected by the number of days that the wind energy will be predicted, the number of days used for the modeling development and the uncertainty due to the distances between the data predicted and the centroid of the modeling data. Therefore, increasing *n* and *m* yields an effective relative decrease in the uncertainty which is expected.

Table 3-12 presents all the statistics parameters for the daily linear models of all the wind farms in the ERCOT region. Table 3-13 shows the uncertainty of applying the linear models to predict the energy generation that they would have had in the year 1999, ranging from 2.3% to 5.4%. The results indicate that the daily models are reasonably reliable for predicting the performance of the wind farm in the base year within the same range of wind conditions.

Also, in the same table is included the uncertainty related to the predicted wind generated for the same wind farms in the 1999 Ozone Season Period using the OSP model, which consider the period of July 15 though Sep 15 – about 63 days. The uncertainty of using OSP models for predicting wind power in the 1999 OSD varies from 5% to 11% for all the wind farms. It shows a significant improvement compared to the uncertainty reported in the 2007 annual report (from 7% to 23%), which used the annual model for predicting 1999 OSD wind power.

Table 3-12: Statistical Parameters of the Determined 2005 Daily Power Production Linear Models.

	Statistical Parameters of 2006 Non-OSP Daily Models						Statistical Parameters of 2006 OSP Daily Models					
Wind Farm	c_0	c_1	AdjR^2	RMSE	CV-RMSE	# Days	c_0	c_1	AdjR^2	RMSE	CV-RMSE	# Days
BRAZ_WND_WND1	-383.05	120.68	0.62	356.72	38.2%	196	-620.49	129.51	0.63	262.97	46.5%	63
BRAZ_WND_WND2	-189.84	66.28	0.61	194.99	37.8%	230	-337.22	72.92	0.59	161.75	48.9%	63
BUFF_GAP_UNIT1	-383.30	129.61	0.65	351.67	32.5%	301	-844.94	170.76	0.88	164.84	22.9%	63
CALLAHAN_WND1	-460.55	145.94	0.76	303.64	25.5%	301	-799.83	173.51	0.85	193.07	24.5%	63
H_HOLLOW_WND1	-620.45	236.58	0.73	533.46	25.9%	293	-1305.16	274.76	0.85	300.00	24.8%	63
HHOLLOW2_WIND1*	-379.61	183.45	0.59	546.01	33.9%	106	-1134.77	222.81	0.85	241.00	38.5%	15
HHOLLOW3_WND_1*	-572.24	219.73	0.63	590.85	33.8%	150	-1049.85	236.48	0.85	265.73	23.8%	63
HHOLLOW4_WND_1*	-213.14	113.65	0.55	350.86	34.8%	120	-640.13	133.60	0.83	157.54	27.0%	63
INDNENR_INDNENR	-400.67	102.57	0.46	320.70	43.4%	298	-579.80	117.98	0.53	229.95	45.5%	63
INDNENR_INDNENR_2	-397.37	96.11	0.44	314.81	46.9%	300	-544.64	108.64	0.52	218.40	48.0%	63
KING_NE_KINGNE	-278.17	77.47	0.57	212.00	38.4%	302	-356.88	76.23	0.50	154.77	48.1%	63
KING_NW_KINGNW	-151.36	73.45	0.40	287.50	45.2%	302	-329.15	82.83	0.47	176.80	43.3%	63
KING_SE_KINGSE	-146.33	38.70	0.56	109.84	40.9%	302	-209.60	41.60	0.51	83.33	51.9%	63
KING_SW_KINGSW	-188.12	71.18	0.47	240.61	41.9%	302	-348.37	80.58	0.52	156.37	42.4%	63
RDCANYON_RDCNY1*	-116.87	93.10	0.52	315.20	35.2%	99	-116.87	93.10	0.52	315.20	35.2%	99
SWEETWN2_WND2	-343.07	118.56	0.77	242.57	24.3%	294	-624.95	133.25	0.79	186.22	30.7%	60
SWEETWN3_WND3	-321.41	138.59	0.72	324.10	26.0%	296	-735.99	162.64	0.79	224.06	29.2%	60
SWEETWND_WND1	-191.15	50.87	0.77	104.24	27.1%	293	-272.06	55.62	0.82	69.45	28.7%	60
TRENT_TRENT	-758.44	198.46	0.74	434.50	29.2%	301	-1087.80	220.61	0.84	252.23	27.0%	63
DELAWARE_WIND_NWP	*-93.97*	*15.46*	*0.72*	*66.88*	*32.3%*	*294*	*-101.89*	*14.04*	*0.68*	*35.94*	*37.1%*	*61*
INDNNWP_INDNNWP	*-392.43*	*96.66*	*0.41*	*335.62*	*49.2%*	*300*	*-508.36*	*108.14*	*0.53*	*213.17*	*43.8%*	*63*
KUNITZ_WIND	*-137.73*	*16.28*	*0.70*	*73.27*	*41.0%*	*296*	*-104.59*	*11.95*	*0.75*	*25.93*	*40.2%*	*61*
SGMTN_SIGNALMT	*-13.39*	*29.07*	*0.33*	*131.40*	*44.1%*	*302*	*-138.39*	*35.52*	*0.40*	*88.84*	*50.0%*	*63*
SW_MESA_SW_MESA	*-170.20*	*72.62*	*0.40*	*280.77*	*0.46*	*302*	*-378.94*	*90.26*	*0.45*	*202.16*	*0.48*	*63*
WOODWRD1_WOODWRD1	*-471.94*	*90.83*	*0.59*	*220.53*	*41.0%*	*300*	*-602.03*	*106.58*	*0.71*	*142.20*	*37.6%*	*63*
WOODWRD2_WOODWRD2	*-457.84*	*87.73*	*0.63*	*197.36*	*38.1%*	*300*	*-572.38*	*101.52*	*0.71*	*136.35*	*37.7%*	*63*

Table 3-13. 1999 Annual and OSP Uncertainty of the Power Generation Prediction using the Linear Daily Models.

	1999 Non Ozone Season Period				1999 Ozone Season Period (OSP)			
Wind Farm	Predicted days	Total Variance	Total Estimated	Relative Uncertainty	Predicted Days	Total Variance	Total Estimated	Relative uncertainty
BRAZ_WND_WND1	302	12,185.29	348,113	3.50%	63	4,118.86	40,126.0	10.26%
BRAZ_WND_WND2	302	6,661.64	198,702	3.35%	63	2,533.57	23,359.2	10.85%
BUFF_GAP_UNIT1	302	12,002.67	390,430	3.07%	63	2,581.97	51,220.5	5.04%
CALLAHAN_WND1	302	10,363.27	428,993	2.42%	63	3,024.06	55,744.0	5.42%
H_HOLLOW_WND1 *	302	18,207.82	728,851	2.50%	63	4,698.90	85,843.4	5.47%
HHOLLOW2_WIND1*	302	18,721.64	594,059	3.15%	63	3,868.09	64,797.2	5.97%
HHOLLOW3_WND_1*	302	20,218.32	676,954	2.99%	63	4,162.25	78,508.2	5.30%
HHOLLOW4_WND_1*	302	12,024.82	375,919	3.20%	63	2,467.58	41,391.8	5.96%
INDNENR_INDNENR	300	10,916.04	270,994	4.03%	63	3,608.18	37,496.0	9.62%
INDNENR_INDNENR_2	300	10,715.44	246,042	4.36%	63	3,426.89	33,853.0	10.12%
KING_NE_KINGNE	302	7,238.95	201,259	3.60%	62	2,409.18	23,011.5	10.47%
KING_NW_KINGNW	302	9,816.87	231,449	4.24%	63	2,773.74	28,689.7	9.67%
KING_SE_KINGSE	302	3,750.40	98,462	3.81%	62	1,297.03	11,637.8	11.14%
KING_SW_KINGSW	302	8,215.73	210,137	3.91%	63	2,453.26	26,137.6	9.39%
RDCANYON_RDCNY1*	302	10,807.65	341,043	3.17%	63	N/A	31,686.1	N/A
SWEETWN2_WND2	302	8,279.10	354,718	2.33%	63	2,917.40	42,136.9	6.92%
SWEETWN3_WND3	302	11,061.84	442,506	2.50%	63	3,510.20	53,119.1	6.61%
SWEETWND_WND1	302	3,557.81	137,761	2.58%	63	1,088.08	16,883.3	6.44%
TRENT_TRENT	302	14,829.57	534,218	2.78%	63	3,950.67	66,409.9	5.95%
DELAWARE_WIND_NWP	*302*	*2,281.84*	*67,452*	*3.38%*	*61*	*557.45*	*5,869.6*	*9.50%*
INDNNWP_INDNNWP	*300*	*11,423.87*	*251,397*	*4.54%*	*63*	*3,344.82*	*35,822.5*	*9.34%*
KUNITZ_WIND	*302*	*2,499.70*	*57,072*	*4.38%*	*59*	*395.74*	*3,910.0*	*10.12%*
SGMTN_SIGNALMT	*302*	*4,486.56*	*106,777*	*4.20%*	*63*	*1,393.76*	*12,475.1*	*11.17%*
SW_MESA_SW_MESA	*302*	*9,587.13*	*224,262*	*4.27%*	*63*	*3,171.62*	*29,990.7*	*10.58%*
WOODWRD1_WOODWRD1	*300*	*7,506.38*	*200,746*	*3.74%*	*63*	*2,231.27*	*28,942.8*	*7.71%*
WOODWRD2_WOODWRD2	*300*	*6,717.90*	*192,956*	*3.48%*	*63*	*2,139.50*	*27,638.9*	*7.74%*

4 DEGRADATION ANALYSIS FOR WIND FARMS

The analysis contained in this section is an update of the work reported in the 2007 annual report in response to a request by the TCEQ to determine what amounts of degradation could be observed in the measured power from Texas wind farms. Currently, the TCEQ uses a very conservative 5% degradation per year for the power output from a wind farm when making future projections from existing wind farms. Accordingly, the TCEQ asked the ESL to evaluate any observed degradation from the measured data for Texas wind farms. To accomplish this, nine wind farms (12 sites) in Texas from 2002 to 2006 were evaluated. These wind farms were built before January 2002, with a total capacity of 1,010 MW.

In this analysis, a sliding statistical index was established for each site that uses 10^{th}, 25^{th}, 50^{th}, 75^{th}, 90^{th}, and 99^{th} percentiles of the hourly power generation over a 12-month sliding period[3], as well as mean, minimum and maximum hourly power generation of the same 12-month period. These indices are then displayed using one data symbol for each 12-month slide, beginning from the first 12-month period (January 2002 to December 2002) until the last 12-month period (January 2006 to December 2006) for each of the wind farms, as shown from Figure 4-4 and Figure 4-12. The 90^{th} percentile values were chosen to present the degradation for each wind farm[4]. In addition, our analysis revealed that the maximum hourly power generation over a 12-month period was also a useful index to watch, since this facilitated a way to see if there was major operation change, i.e., shut down of wind turbines, during the studied 5-year period.

Table 4-1 presents the summary of the degradation analysis for the nine wind farms. Of the 12 sites analyzed, nine sites showed an increase when one compares the 90^{th} percentile from January 2002 to December 2006 to the 90^{th} percentile of the first 12-month period, ranging from 4.2% to 17.9%. The remaining three sites showed a decrease from -5.9% to -11.8%. The weighted average of this increase across all wind farms studied is 7.9% (positive), which indicates that no degradation was observed from the aggregate energy production from these wind farms over a five year operation period.

Table 4-2 and Figure 4-13 show the design capacity, the maximum and minimum of the observed maximum hourly wind power over the sliding 12-month period, and the observed maximum hourly wind power for the last 12-month period for the studied wind farms. It is interesting to note that the observed maximum hourly wind power generation is slightly lower than the design/announced capacity for the majority of the sites. In total, the maximum hourly wind power output during the five-year period (2002-2006) is 963 MW for nine wind farms, 47 MW (5%) lower than the design capacity. It also shows that, for some sites, the maximum hourly wind power over the last 12-month period is lower than the maximum hourly wind power measured during the 5-year period. The total decrease from all wind farms is 21 MW, which is about 2% of total design capacity. Additional operation information will be needed from the owners of the wind farms or ERCOT to explain this observation, such as maintenance records, curtailment, etc.

[3] To calculate this, the hourly data for the 12-month period is converted into quartiles, and those quartiles are recorded in a table. Then, the oldest month is dropped from the dataset and a new month is added, and the quartiles recalculated and recorded, etc.

[4] The choice of the 90^{th} percentile is consistent with the recommendation by Abushakra, B., Haberl, J., Claridge, D. 2004. "Overview of Literature on Diversity Factors and Schedules for Energy and Cooling Load Calculations (1093-RP)," *ASHRAE Transactions-Research*, Vol. 110, Pt. 1 (February), pp. 164-176; and in Claridge, D., Abushakra, B., Haberl, J. 2003. "Electricity Diversity Profiles for Energy Simulation of Office Buildings (1093-RP)," *ASHRAE Transactions-Research*, Vol. 110, Pt. 1 (February), pp. 365-377.

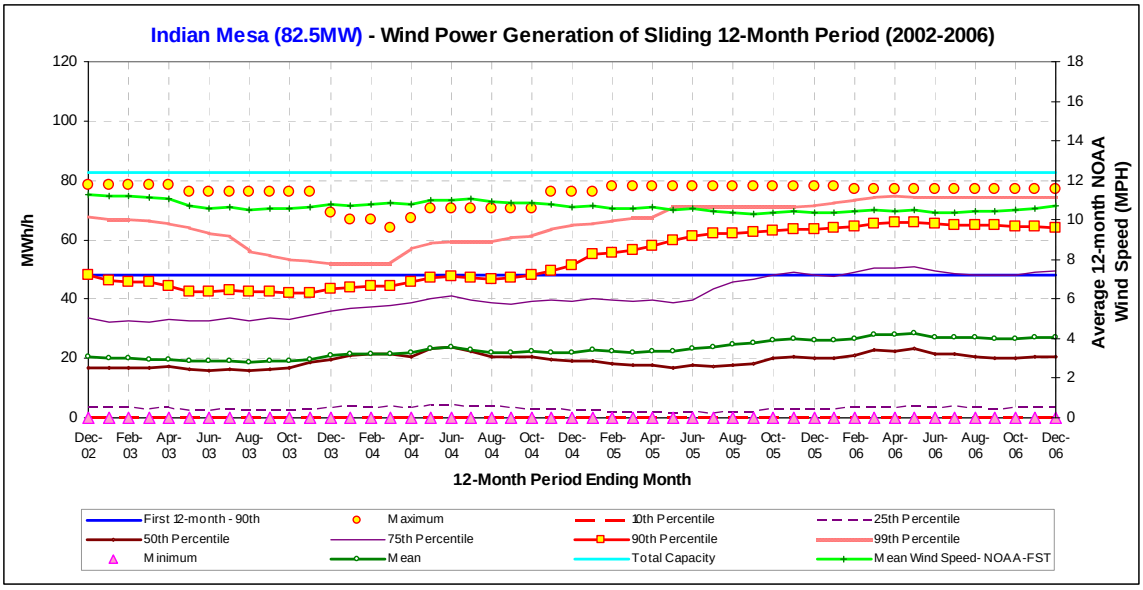


Figure 4-1: Sliding 12-month Hourly Wind Power Generation for Indian Mesa.

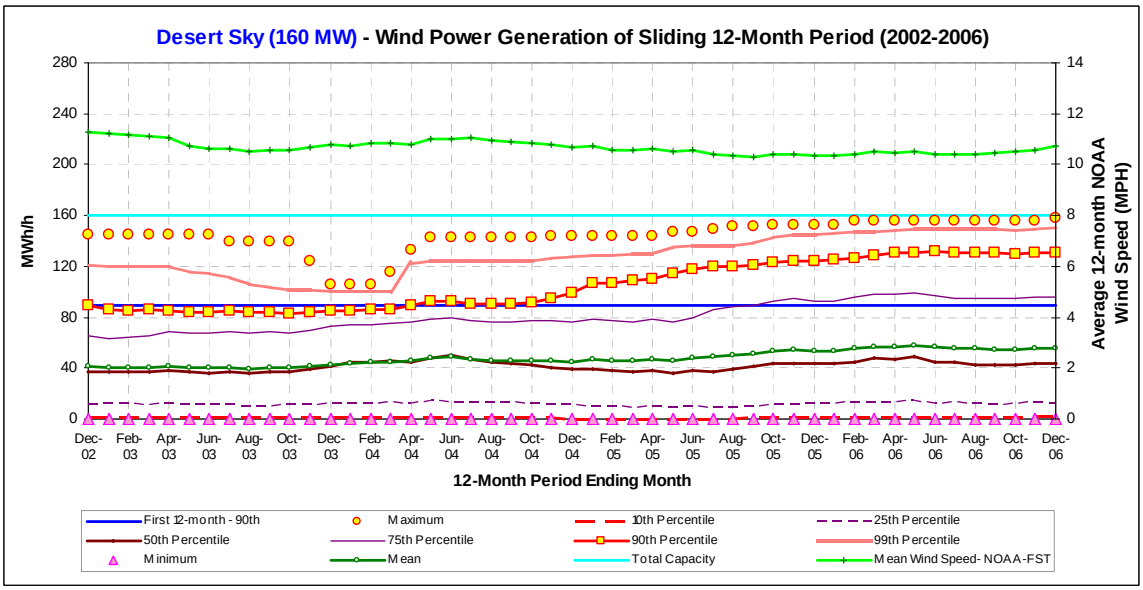


Figure 4-2: Sliding 12-month Hourly Wind Power Generation for Desert Sky.

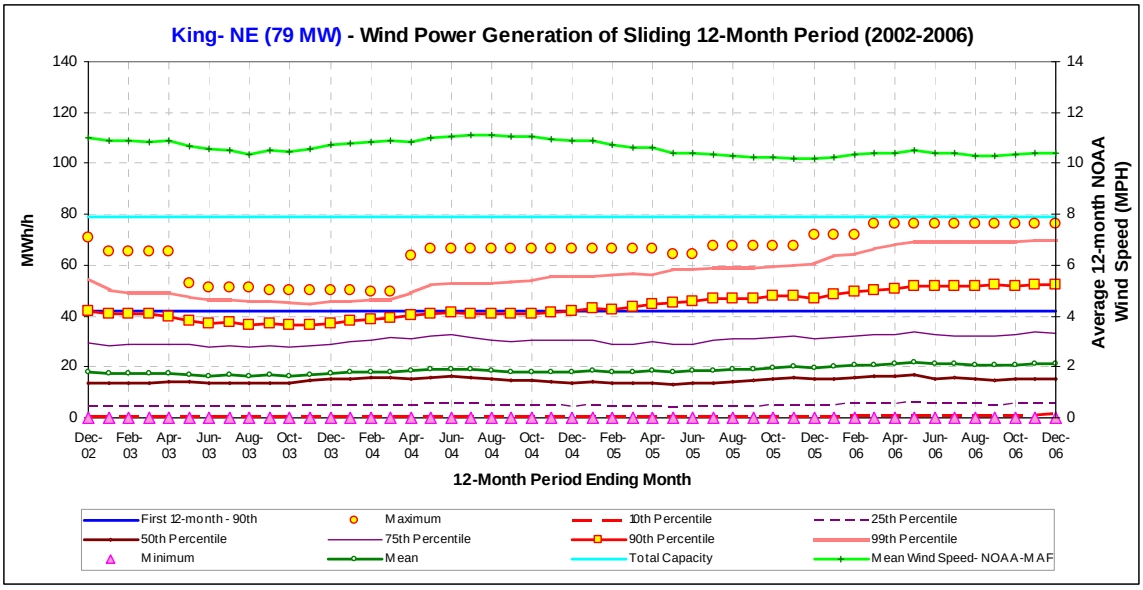


Figure 4-3: Sliding 12-month Hourly Wind Power Generation for King Mountain – NE.

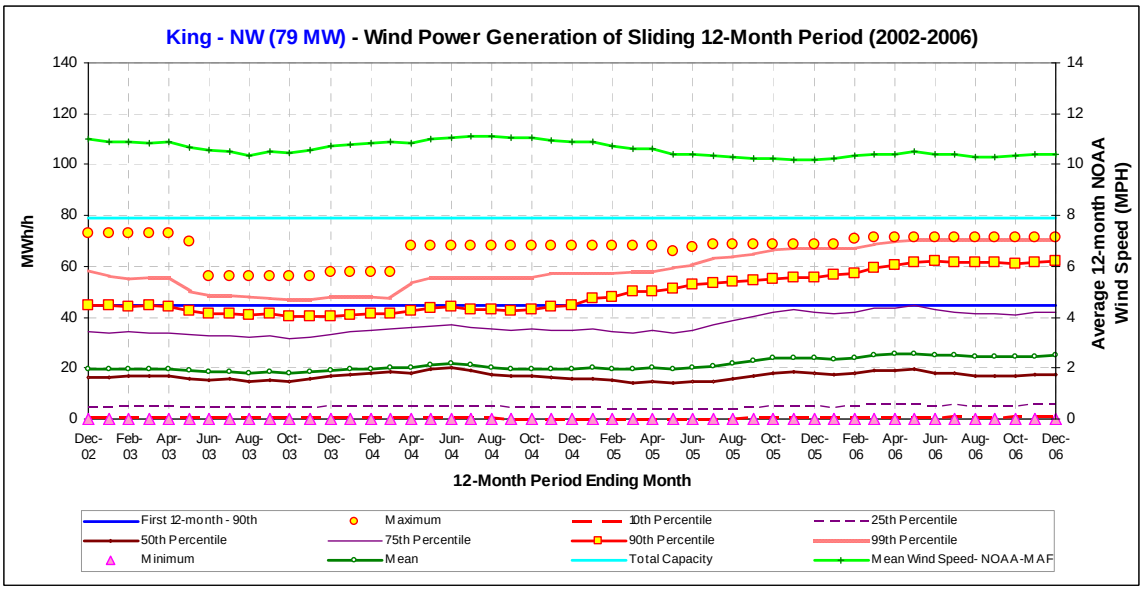


Figure 4-4: Sliding 12-month Hourly Wind Power Generation for King Mountain – NW.

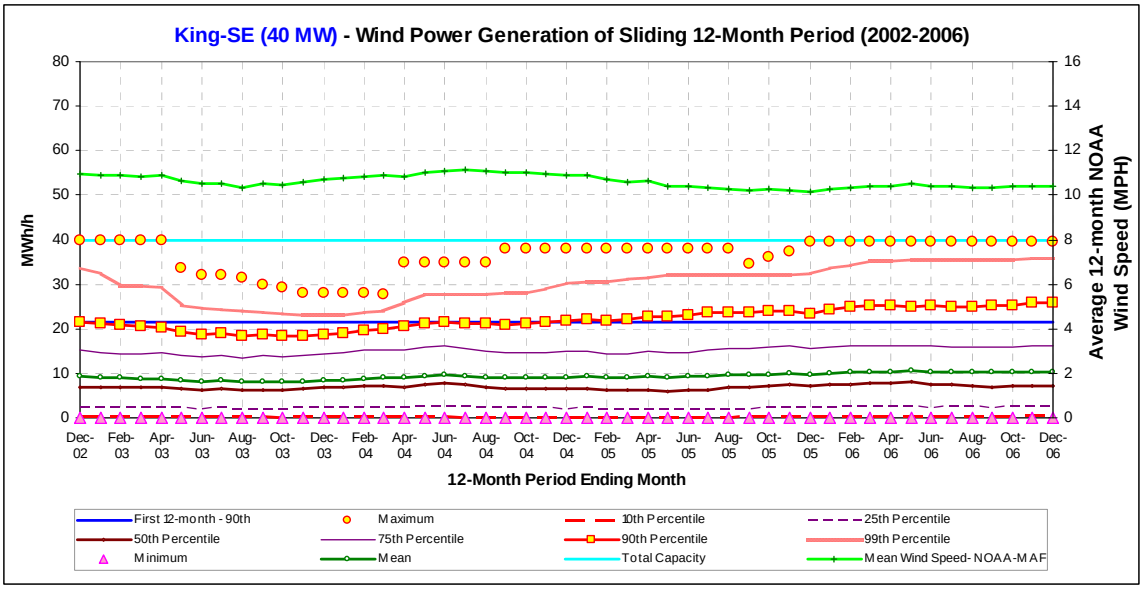


Figure 4-5: Sliding 12-month Hourly Wind Power Generation for King Mountain – SE.

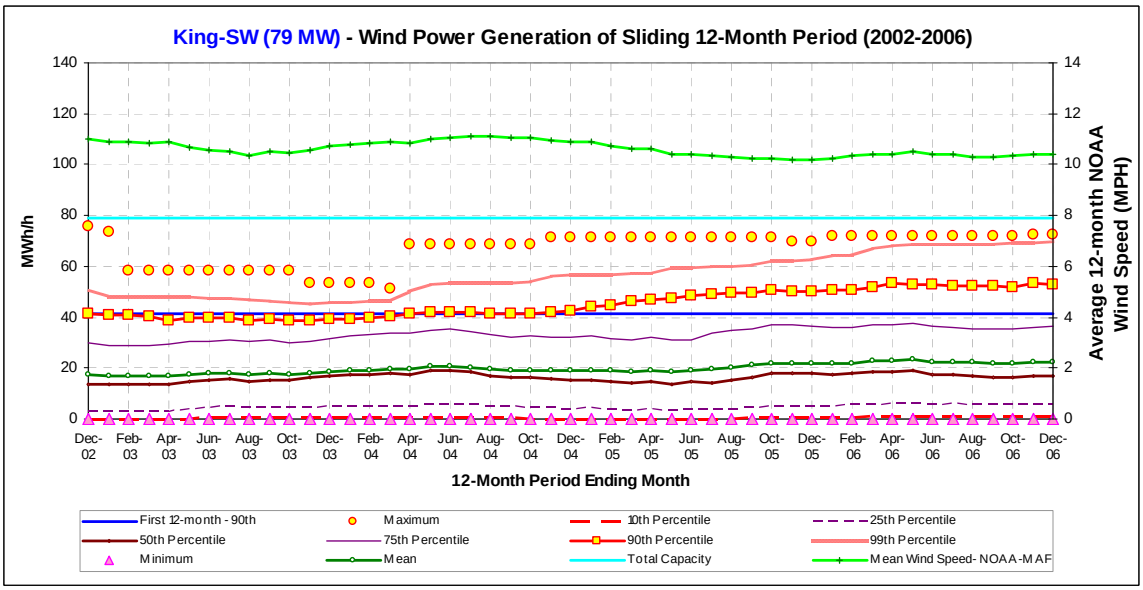


Figure 4-6: Sliding 12-month Hourly Wind Power Generation for King Mountain – SW.

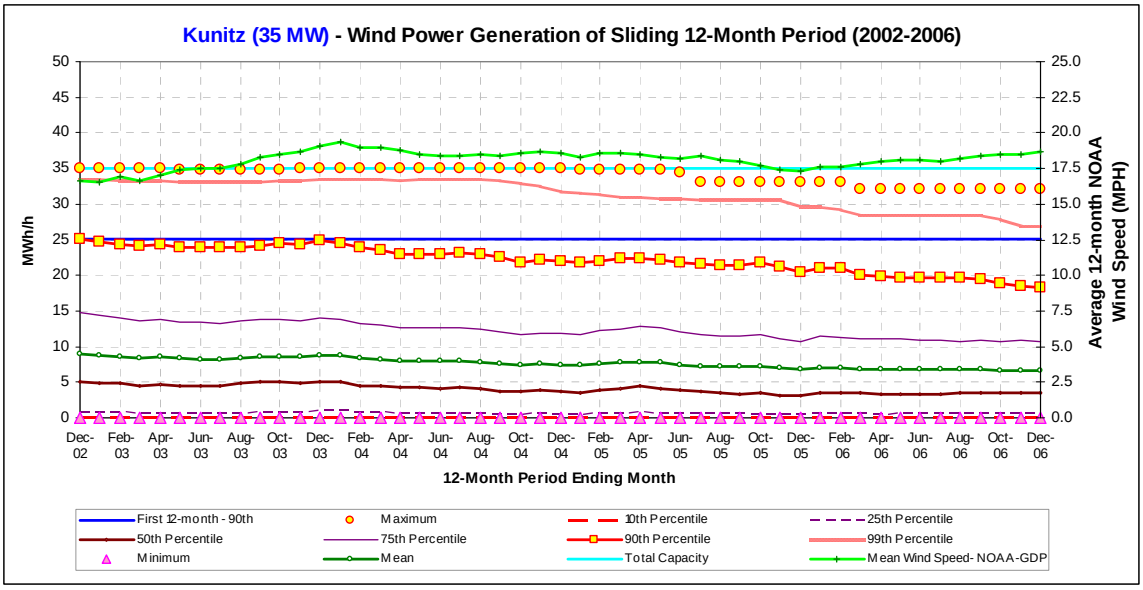


Figure 4-7: Sliding 12-month Hourly Wind Power Generation for Kunitz.

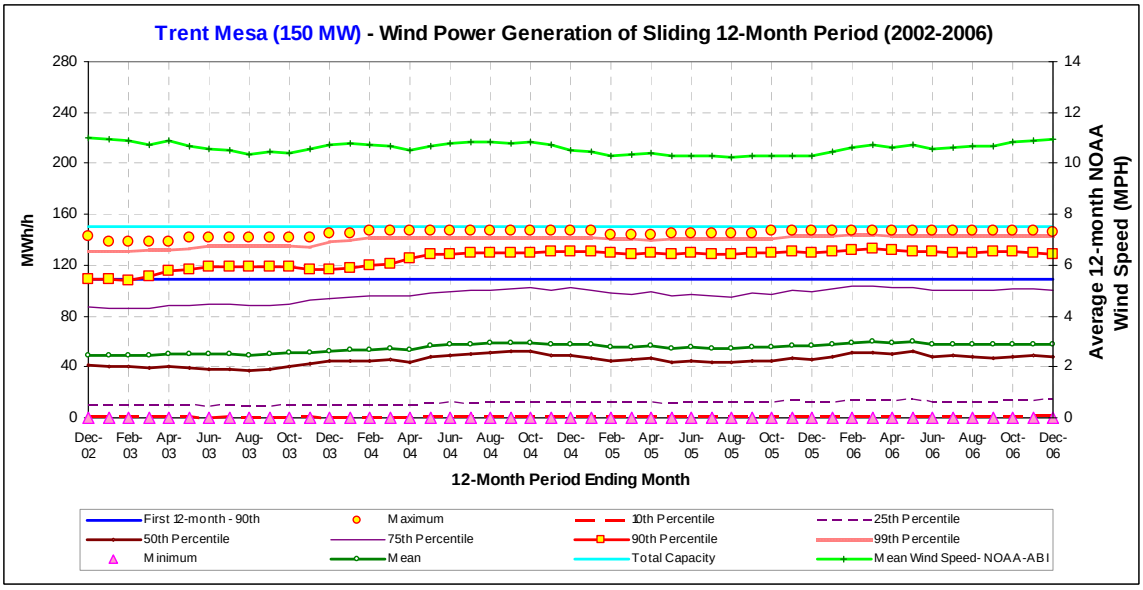


Figure 4-8: Sliding 12-month Hourly Wind Power Generation for Trent Mesa.

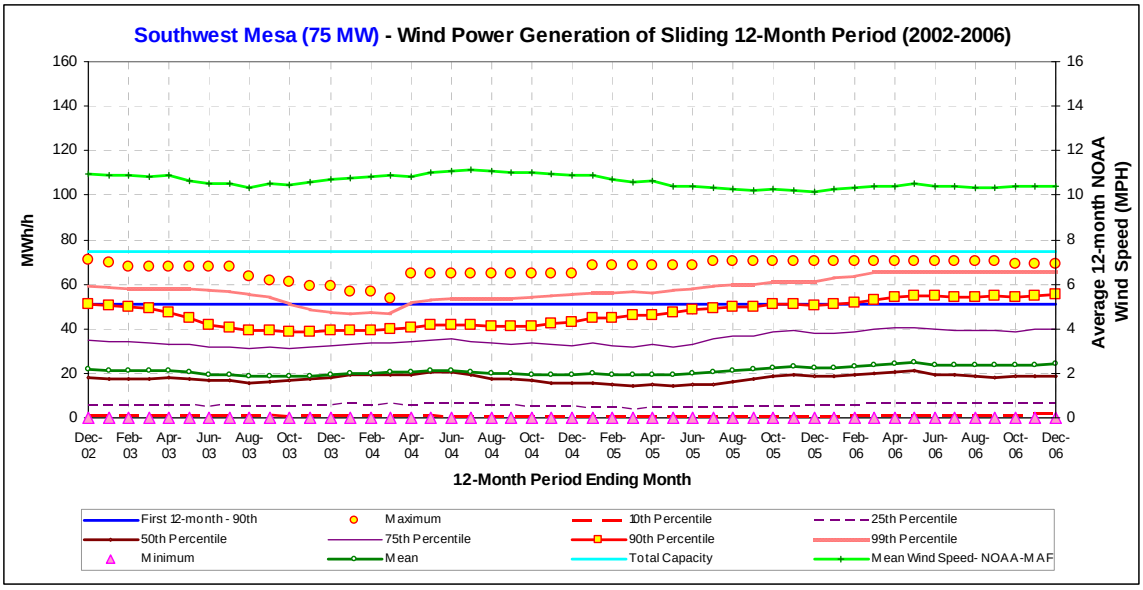


Figure 4-9: Sliding 12-month Hourly Wind Power Generation for Southwest Mesa.

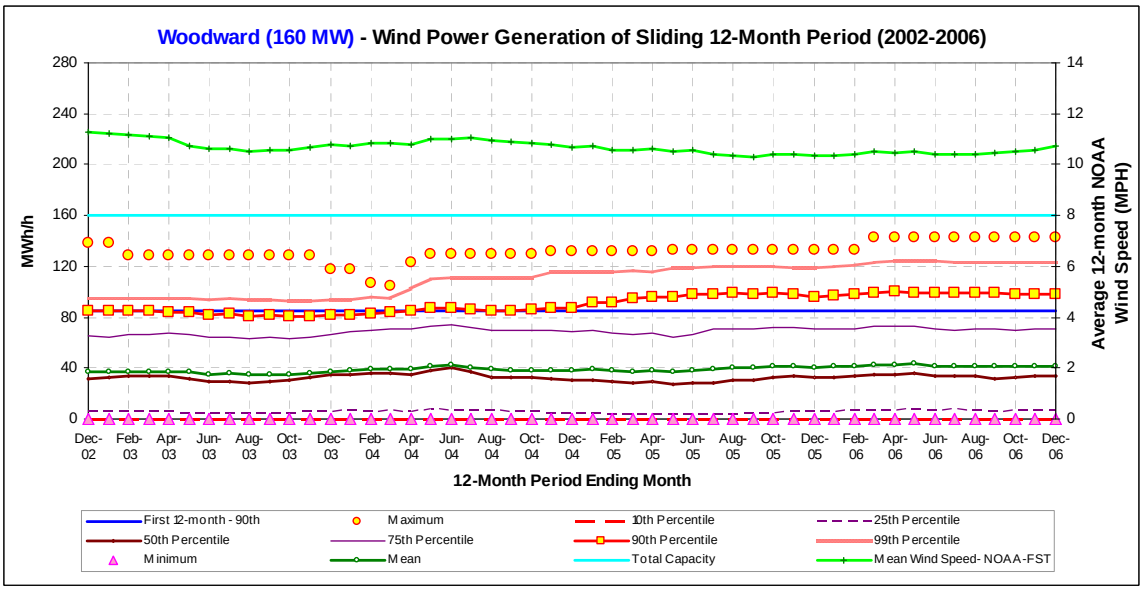


Figure 4-10: Sliding 12-month Hourly Wind Power Generation for Woodward.

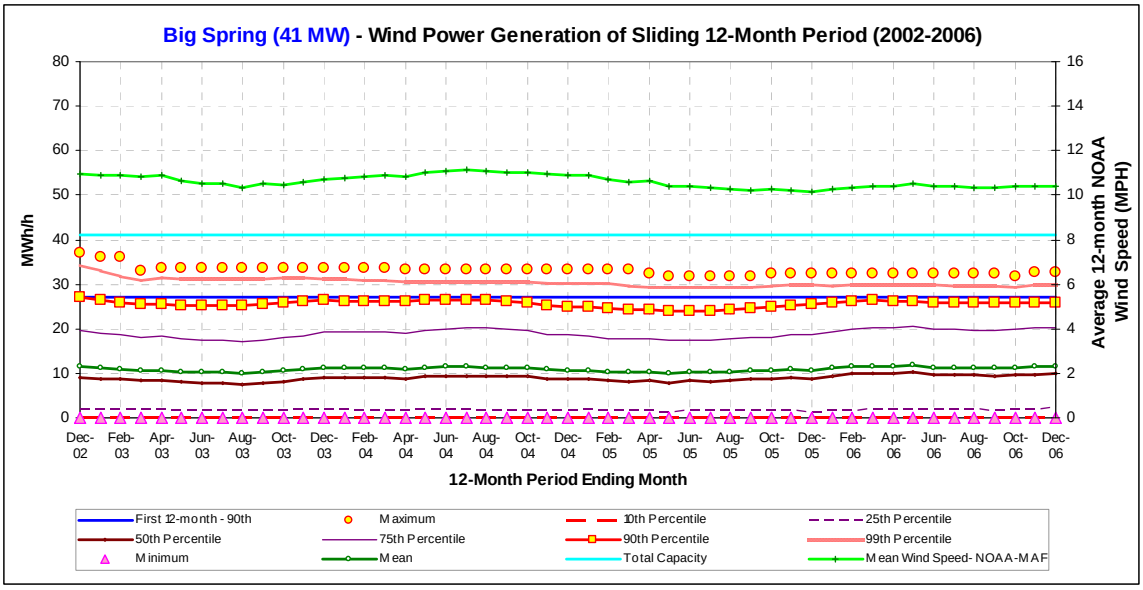


Figure 4-11: Sliding 12-month Hourly Wind Power Generation for Big Spring.

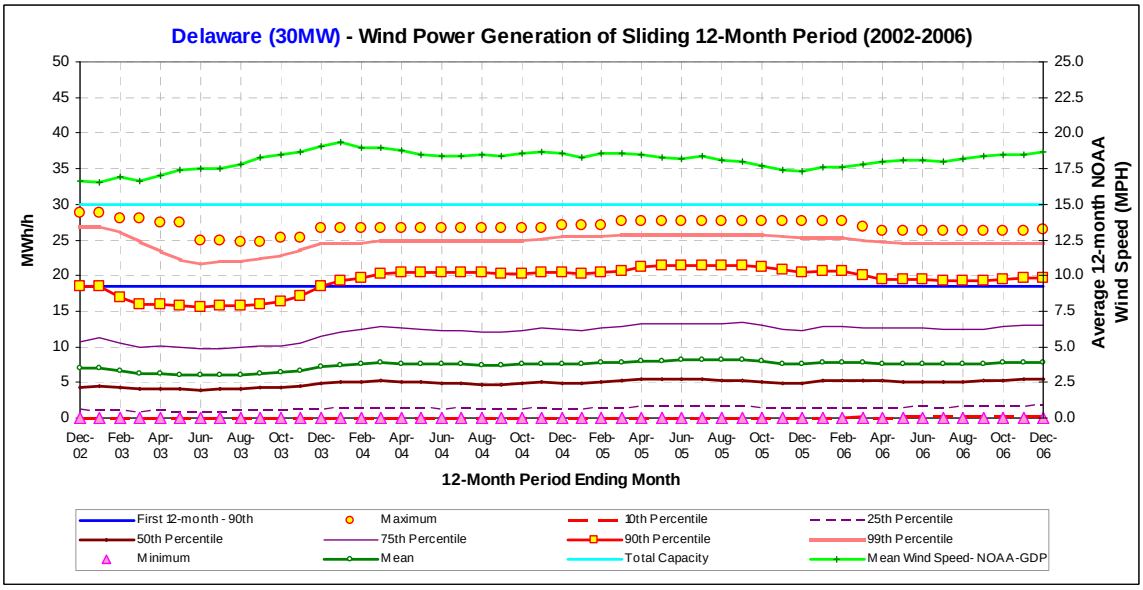


Figure 4-12: Sliding 12-month Hourly Wind Power Generation for Delaware.

Table 4-1: Summary of 90th Percentile Hourly Wind Power Analysis for Nine Wind Farms in Texas.

Wind Farm	First 12-mo 90th Percentile Hourly Wind Power		Average of the Sliding 12-mo 90th Precentile Hourly Wind Power		Minimum of the Sliding 12-mo 90th Precentile Hourly Wind Power		Maximum of the Sliding 12-mo 90th Precentile Hourly Wind Power		No. of Month of Data	Capacity (MW)
	First 12-mo Ending Mo.	MW	MW	% Diff. vs. First 12-mo	MW	% Diff. vs. First 12-mo	MW	% Diff. vs. First 12-mo		
Indian Mesa	Dec-02	48.0	53.8	12.1%	42.1	-12.2%	66.0	37.5%	60	82.5
Delaware	Dec-02	18.6	19.3	4.2%	15.6	-15.8%	21.5	15.7%	60	30
Desert Sky	Dec-02	89.0	105.0	17.9%	83.1	-6.7%	131.3	47.5%	60	160
King Mountain-NE	Dec-02	41.8	43.9	4.9%	36.3	-13.2%	52.5	25.5%	60	79
King Mountain-NW	Dec-02	44.7	49.4	10.5%	40.2	-10.1%	62.3	39.3%	60	79
King Mountain-SE	Dec-02	21.6	22.1	2.0%	18.4	-15.0%	25.8	19.1%	60	40
King Mountain-SW	Dec-02	41.6	45.2	8.7%	38.4	-7.6%	53.4	28.5%	60	79
Trent	Dec-02	108.8	125.2	15.1%	108.2	-0.6%	132.8	22.0%	60	150
Woodward	Dec-02	85.3	90.8	6.5%	80.4	-5.7%	100.3	17.6%	60	160
Kunitz	Dec-02	25.2	22.2	-11.8%	18.3	-27.1%	25.2	0.0%	60	35
Big Spring	Dec-02	27.2	25.6	-5.9%	23.9	-12.0%	27.2	0.0%	60	41
Southwest Mesa	Dec-02	51.1	46.7	-8.6%	38.5	-24.6%	55.3	8.2%	60	75
Weighted Average:				**7.9%**		**-9.8%**		**25.8%**	**Total:**	**1010.5**

Table 4-2: Summary of Maximum Hourly Wind Power Analysis for Nine Wind Farms in Texas.

Wind Farm	Design Capacity (A)	Maximum of the Sliding 12-mo Maximum MW-Measured (B)	Minimum of the Sliding 12-mo Maximum MW - Measured (C)	Maximum MW in Last 12-mo - Measured (D)	Difference (A-B)	Difference (B-D)
Indian Mesa	82.5	78.5	63.9	77.0	4.1	1.4
Delaware	30	28.9	24.8	26.4	1.1	2.5
Desert Sky	160	157.7	105.8	157.7	2.3	0.0
King Mountain-NE	79	76.2	49.8	76.2	2.8	0.0
King Mountain-NW	79	73.2	56.2	71.3	5.8	2.0
King Mountain-SE	40	40.0	27.8	39.6	0.0	0.4
King Mountain-SW	79	75.9	51.2	72.4	3.1	3.5
Trent	150	147.6	138.8	146.2	2.4	1.4
Woodward	160	142.3	104.1	142.3	17.7	0.0
Kunitz	35	35.0	32.2	32.2	0.0	2.9
Big Spring	41	37.0	31.7	32.5	4.0	4.5
South Mesa	75	71.2	53.8	68.8	3.8	2.3
Total:	**1010.5**	**963.3**	**740.0**	**942.5**	**47.2**	**20.9**

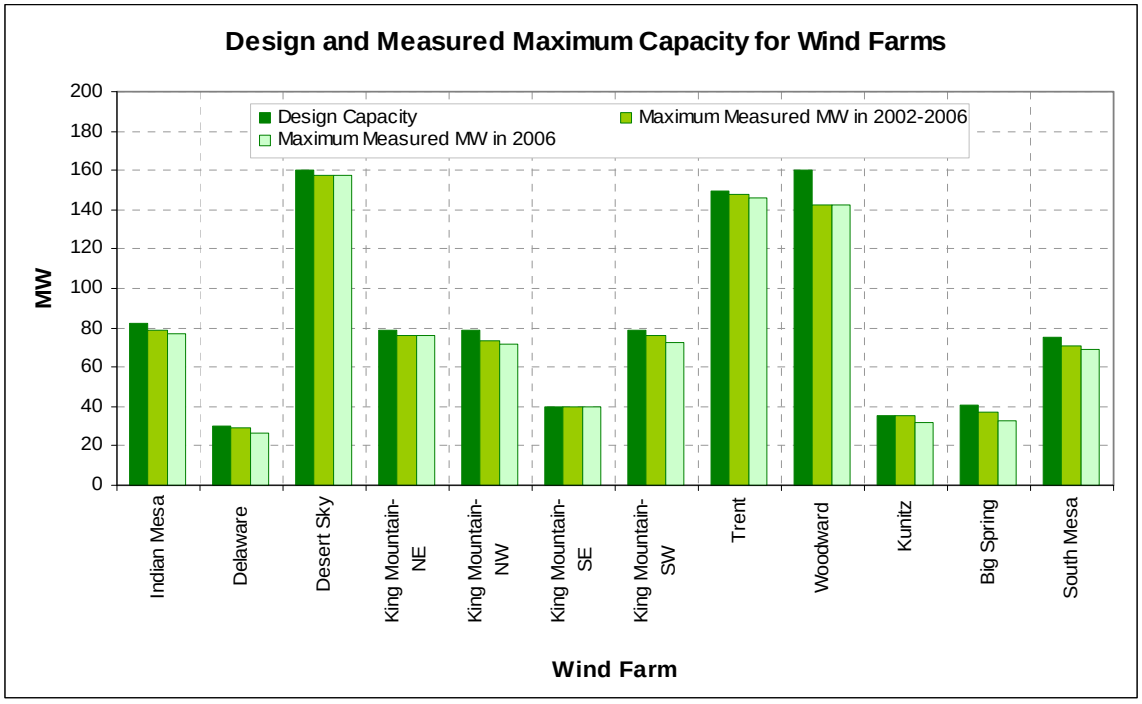


Figure 4-13: Design and Measured Maximum Capacity for Nine Wind Farms.

5 CALCULATING NOX EMISSIONS REDUCTION FROM WIND POWER

5.1 Calculation of NOx Emissions from Wind Power Using 2007 eGRID

The Energy Systems Laboratory has worked closely with the TCEQ and EPA to develop creditable procedures for calculating NO_x reductions from electricity savings using the EPA's Emissions and Generation Resource Integrated Database (eGRID). Calculating NOx emissions from wind power to counties within the ERCOT region encounters some major complications. First, electricity can be generated from different primary energy sources which results in very different NOx emissions. Second, the combination of generation resources used to meet loads may vary during each day or different seasons. Third, electricity is transported over long distances by complex, interconnected transmission and distribution systems. Therefore, the generation source related to electricity usage can be difficult to trace and may occur far from the jurisdiction in which that energy is consumed. Due to the limited availability of public data and the fact that the eGRID database aggregates the emissions on the basis of PCA's[5], the decision was made by the TCEQ and EPA to calculate and assign emissions, according to the PCA where it was generated. A similar decision has been used in California (Marnay et al. 2002). This assumption does not address the deregulation of generation, but provides a good estimation of the emissions reduction from wind power electric production for the base year of 1999, which is currently in use by the TCEQ using the EPA's eGRID.

The procedure presented in this section calculates annual and peak-day, county-wide NO_x reductions from electricity savings from wind projects implemented in the Power Control Areas in ERCOT listed in the EPA's eGRID. For this purpose, a special version of eGRID[6] was developed by the EPA for the TCEQ that reflects the 2007 electricity and pollution from electric utilities in ERCOT. The NOx production for each power plant is provided from the 2007 eGRID database for ten electric utility suppliers. This eGRID matrix was utilized to assign the power plant used by the utility provider, once the utility provider had been chosen for a given county. Figure 5-1 shows a snapshot of the NOx emission distribution among Texas counties from generating one mega-watt-hour of electricity in the power control area of AEP-West, which was derived from the 2007 Annual eGRID table. For example, the counties marked in red show higher NOx emissions of above 0.08 lbs/MWh. The counties marked in green were least impacted by the NOx emissions (less than 0.0005 lbs/MWh) from the power plants assigned to AEP-West. Figure 5-2 and Figure 5-3 show the same county-wide NOx emissions distribution from TXU and LCRA.

To calculate the NOx emissions reduction from the wind projects within the ERCOT region, the total MWh wind power for each Power Control Area are summarized in Table 5-1. The assignment of PCA to each wind farm was based on the information provided by the PUCT to ESL in 2005 and 2007 as shown in Table 5-2 and Table 5-3, respectively. The total MWh production in each PCA was input in the corresponding cells in the eGRID table to calculate the total annual and OSD emissions reduction for the entire ERCOT region (Table 5-4 and Table 5-5).

According to the developed models, the total MWh savings in the base year 1999 for the wind farms within the ERCOT region is 6,919,352 MWh and 15,269 MWh/day in the Ozone Season Period. The total NOx emissions reductions across all the counties amount to 4,059 tons/yr and 9 tons/day for the Ozone Season Period. The distribution of the NOx emissions reduction in the counties within the ERCOT region is shown in Figure 5-4, Figure 5-5, Figure 5-6, and Figure 5-7. Based on the 2007 eGRID, it is shown that the counties in the gulf coast area will get emissions benefit from the wind farms located in the west. Figure 2 shows the average modeled power flows during 2006 for each of the Commercially Significant Constraints from ERCOT[7]. Based on modeled flows, Houston is a significant importer from the 'North Zone' and the 'South Zone,' while the 'South Zone' and the 'Northeast Zone' export significant amounts of power. So any modifications on the generation patterns in the north area could affect the generation on the South area

[5] A Power Control Area (PCA) is defined as one grid region for which one utility controls the dispatch of electricity. Some smaller utilities are embedded in the power control areas of larger utilities. The corresponding PCA for wind farms was obtained from PUCT.
[6] This 2007 eGRID table for Texas was provided by Art Diem of the USEPA and includes emissions values for AEP, Austin Energy, Brownsville Public Utility, LCRA, Reliant, San Antonio Public Service, South Texas Coop, TMPP, TNMP, and TXU.
[7] ERCOT, "2006 State of the Market Report for the ERCOT Wholesale Electricity Markets" Available at: http://www.puc.state.tx.us/WMO/documents/annual_reports/2006annualreport.pdf

(Gulf coast) which has a larger emissions rate than the north counterpart, thus giving a major emissions reduction impact. Therefore, we believe the distribution of electricity is adequately reflected in the current choice of the PCAs continued in the 2007 eGRID.

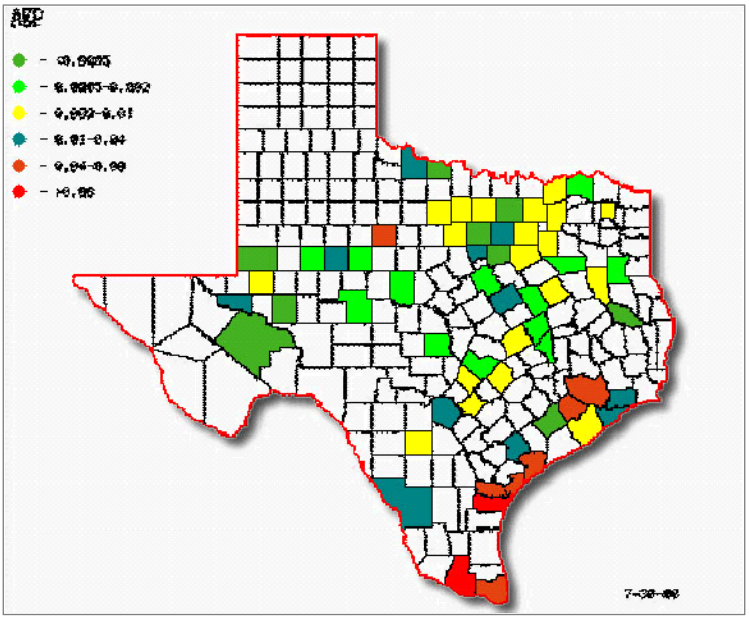


Figure 5-1: NOx Emissions (lbs/MWh) from PCA-AEP West in the 2007 Annual eGRID.

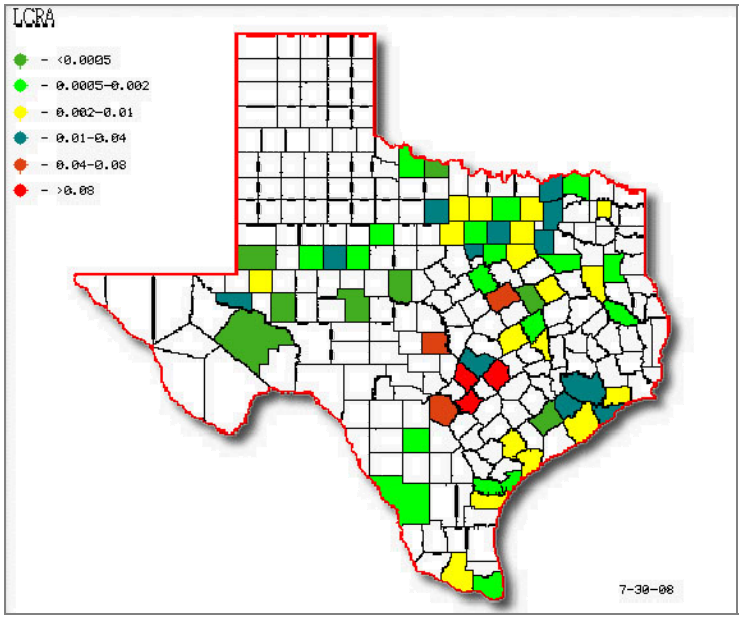


Figure 5-2: NOx Emissions (lbs/MWh) from PCA-LCRA in the 2007 Annual eGRID.

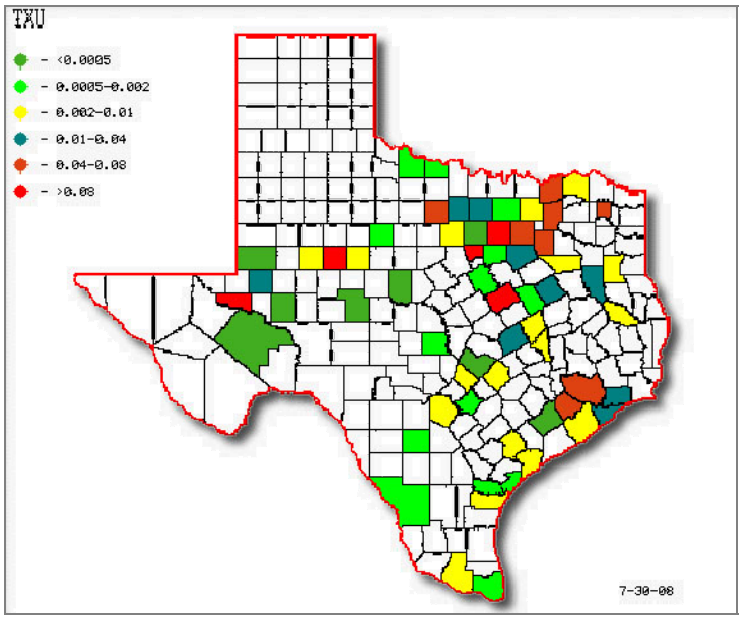


Figure 5-3: NOx Emissions (lbs/MWh) from PCA-TXU in the 2007 Annual eGRID.

Table 5-1: Wind Power Production Assigned to Each PCA in the ERCOT Region.

PCA	Annual Wind Power (MWh/yr)	OSD Wind Power (MWh/day)
AEP-WEST	5,218,849	12,082
TXU	708,447	1,345
LCRA	992,057	1,842
Total	6,919,352	15,269

Table 5-2: Wind Farm Information from the PUCT – 2005.

Source: http://www.puc.state.tx.us/electric/maps/gentable.pdf

Map No.	Company	Facility	City (County)	Resource	Capacity (MW)	Date in Service	Interconnection	Region	PCA
7	York Research	Big Spring Wind Power	Big Spring (Howard)	Wind	34	Feb-99	TXU	ERCOT	TXU
8	FPL Energy	Southwest Mesa Wind Project	McCamey (Upton)	Wind	75	Jun-99	WTU	ERCOT	AEP-West
9	American National Wind Power	Delaware Mountain Wind Farm	Delaware Mountains (	Wind	30	Jun-99	TXU	ERCOT	TXU
10	York Research	Big Spring Wind Power	Big Spring (Howard)	Wind	6.6	Jun-99	TXU	ERCOT	TXU
33	Orion Energy/American National Win	Indian Mesa I	(Pecos)	Wind	82.5	Jun-01	WTU	ERCOT	AEP-West
35	FPL/Cielo/TXU	Woodward Mountain Ranch	McCamey (Pecos)	Wind	160	Jul-01	WTU	ERCOT	AEP-West
44	AEP	Trent Mesa	Trent Mesa (Nolan)	Wind	150	Nov-01	TXU	ERCOT	TXU
45	AEP	Desert Sky (Indian Mesa II)	Iraan (Pecos)	Wind	160	Dec-01	WTU	ERCOT	AEP-West
46	FPL/Cielo	King Mountain Wind Ranch	McCamey (Upton)	Wind	278	Dec-01	WTU	ERCOT	AEP-West
65	Cielo/Orion/Green Mountain	Brazos Wind Ranch	Fluvana (Scurry)	Wind	160	Dec-03	ONCOR	ERCOT	AEP-West
66	DKR/Babcock&Brown/Catamount	Sweetwater 1	Sweetwater (Nolan)	Wind	37.5	Dec-03	LCRA	ERCOT	LCRA
75	FPL Energy	Callahan Divide Wind Energy C	Abilene (Taylor)	Wind	114	Feb-05	AEP-TNC	ERCOT	AEP-West
Map No.	Company	Facility	City (County)	Resource	apacity (MV	ed Date in S	ted Date in S	Region	
79	Clipper Windpower Dev.	Silver Star Phase I	(Eastland)	Wind	60	2005	5-Jun	ERCOT	TXU
80	DKRW Development	Sweetwater II	Sweetwater (Nolan)	Wind	89	2005	5-Dec	ERCOT	TXU
81	AES Corporation	Buffalo Gap	Abilene (Taylor)	Wind	120	1Q-05	4Q-05	ERCOT	AEP-West
84	Orion Energy		(Culberson)	Wind	175	NA	6-Dec	ERCOT	TXU

Capacity (MW)	PCA (1998 Designation)	Percent of Total Capacity
1149.5	AEP-West	66.38%
37.5	LCRA	2.17%
544.6	TXU	31.45%
1731.6	*TOTAL*	*100.00%*

Table 5-3: Wind Farm Information from the PUCT – 2007.

Facility	City	County	Resource	Capacity (MW)	Status	In Service	Intercon-nection	Region
Texas Wind Power Project		Culberson	Wind	35	Completed	10/01/95		ERCOT
Big Spring Wind Power	Big Spring	Howard	Wind	34	Completed	02/01/99	TU	ERCOT
Big Spring Wind Power	Big Spring	Howard	Wind	6.6	Completed	06/01/99	TXU	ERCOT
Southwest Mesa Wind Project	McCamey	Upton	Wind	75	Completed	06/01/99	WTU	ERCOT
Delaware Mountain Wind Farm		Culberson	Wind	30	Completed	06/01/99	TXU	ERCOT
Hueco Mountain Wind Ranch	Hueco Mtn.	El Paso	Wind	1.3	Completed	04/01/01	EPE	WSCC
Indian Mesa		Pecos	Wind	82.5	Completed	06/01/01	WTU	ERCOT
Woodward Mountain Ranch	McCamey	Pecos	Wind	160	Completed	07/01/01	WTU	ERCOT
Trent Mesa	Sweetwater	Nolan	Wind	150	Completed	11/01/01	TXU	ERCOT
Desert Sky (Indian Mesa II)	Iraan	Pecos	Wind	160	Completed	12/01/01	WTU	ERCOT
King Mountain Wind Ranch	McCamey	Upton	Wind	278	Completed	12/01/01	WTU	ERCOT
Llano Estacado Wind Ranch	White Deer	Carson	Wind	79	Completed	01/01/02	SPS	SPP
Brazos Wind Ranch	Fluvana	Scurry	Wind	160	Completed	12/01/03	ONCOR	ERCOT
		Hansford	Wind	3	Completed	12/31/03	SPS	SPP
Sweetwater Wind 1	Sweetwater	Nolan	Wind	37.5	Completed	12/01/03	LCRA	ERCOT
Sweetwater Wind 2	Sweetwater	Nolan	Wind	91.5	Completed	02/01/05	LCRA	ERCOT
Sweetwater Wind 3 (Cottonwood Creek)	Sweetwater	Nolan	Wind	135	Completed	12/01/05	LCRA	ERCOT
Sweetwater Wind 4 (Cottonwood Creek)	Sweetwater	Nolan	Wind	300	Completed	05/07/07	LCRA	ERCOT
Callahan Divide Wind Energy Center	Abilene	Taylor	Wind	114	Completed	02/01/05	AEP-TNC	ERCOT
Buffalo Gap 1	Abilene	Taylor	Wind	120	Completed	09/01/05	AEP/TNC	ERCOT
Buffalo Gap 2 (Cirello 1)	Abilene	Taylor	Wind	233	Completed	08/01/07	AEP/TNC	ERCOT
Horse Hollow Phase 1	Abilene	Taylor	Wind	213	Completed	10/01/05	AEP/TNC	ERCOT
Horse Hollow Phase 2	Abilene	Taylor	Wind	223.5	Completed	05/31/06	AEP/TNC	ERCOT
Horse Hollow Phase 3	Abilene	Taylor	Wind	299	Completed	09/30/06	AEP/TNC	ERCOT
JD Wind 1, 2, 3, 5	Gruver	Hansford	Wind	40	Completed	12/21/06	SPS	SPP
Red Canyon 1		Borden	Wind	84	Completed	05/31/06	BEPC	ERCOT
Forest Creek Wind Farm		Sterling	Wind	124.2	Completed	12/20/06	TXU-ED	ERCOT
Sand Bluff Wind Farm		Sterling	Wind	90	Completed	12/20/06	TXU-ED	ERCOT
Lone Star Wind - Mesquite		Shackleford	Wind	200	Completed	12/31/06	TXU-ED	ERCOT
Wildorado Wind Ranch	Wildorado	Oldham	Wind	161	Completed	04/30/07	SPS	SPP
Camp Springs Wind Energy Center		Scurry	Wind	130	Completed	07/01/07		ERCOT
Capricorn Ridge Wind		Sterling	Wind	262	Completed	09/01/07		ERCOT

Table 5-4: Annual NOx Reductions Using the 1999 Base Year and the 2007 eGrid (25%).

Area	County	American Electric Power - West (ERCOT) /PCA	NOx Reductions (lbs)	Austin Energy/PCA	NOx Reductions (lbs)	Brownsville Public Utils Board/PCA	NOx Reductions (lbs)	Lower Colorado River Auhotrity /PCA	NOx Reductions (lbs)	Reliant Energy HL&P/PCA	NOx Reductions (lbs)	San Antonio Public Service Bd/PCA	NOx Reductions (lbs)	South Texas Electric Coop INC/PCA	NOx Reductions (lbs)	Texas Municipal Power Pool/PCA	NOx Reductions (lbs)	Texas-New Mexico Power Co/PCA	NOx Reductions (lbs)	TXU Electric/PCA	NOx Reductions (lbs)	Total Nox Reductions (lbs)	Total Nox Reductions (Tons)
Houston-Galveston Area	Brazoria	0.008831132	46088.34173	0.010890729	0	0.006522185	0	0.029344232	3912.901279	0.065444292	0	0.014877434	0	0.006262315	0	0.12127495?	0	0.004817148	0	0.008163?	5783.668907	55784.91191	27.89245596
	Chambers	0.021762222	113573.7415	0.026955801	0	0.016072371	0	0.009076193	9004.097335	0.164904225	0	0.037472294	0	0.015055623	0	0.009553214	0	0.011518588	0	0.015818552	11206.63354	133784.4724	66.89223621
	Fort Bend	0.070431234	367569.941	0.087239726	0	0.052016606	0	0.029374182	29140.8514	0.533812376	0	0.121275296	0	0.048726002	0	0.039318012	0	0.037278747	0	0.051195276	36269.13732	432979.9297	216.4899648
	Galveston	0.033856739	176693.1939	0.041710519	0	0.025004711	0	0.015351589	15229.64506	0.249587379	0	0.056747051	0	0.024143087	0	0.015297151	0	0.567751219	0	0.032836887	23263.19227	215186.0312	107.5930156
	Harris	0.068267332	356276.8678	0.084559408	0	0.050418468	0	0.028471701	28245.53944	0.517411736	0	0.117549281	0	0.047228963	0	0.029968099	0	0.03613341	0	0.049622373	35154.81872	419677.226	209.838613
	Liberty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Montgomery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Waller	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beaumont/ Port Arthur Area	Hardin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jefferson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Orange	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dallas/ Fort Worth Area	Collin	0.002039135	10641.93748	0.003716345	0	0.001505992	0	0.005950953	5903.681967	0.002481479	0	0.000717051	0	0.019166247	0	0.07668094	0	0.00086441	0	0.004000199	2833.929009	19379.54846	9.68977423
	Dallas	0.004539471	23690.81234	0.004683963	0	0.003352602	0	0.00774211	7680.611356	0.002085611	0	0.00068106	0	0.007502816	0	0.026717045	0	0.007524933	0	0.040370454	28600.32503	59971.74872	29.98587436
	Denton	0.00047388	2473.109471	0.000872802	0	0.000349982	0	0.001396994	1385.896977	0.000585443	0	0.000168971	0	0.00454374	0	0.018187155	0	0.000186605	0	0.000849405	601.758656	4460.765104	2.230382552
	Tarrant	0.012162492	63474.20529	0.012266309	0	0.008982543	0	0.020308652	20147.33265	0.005316504	0	0.00175206	0	0.017326428	0	0.062016761	0	0.020603444	0	0.110647237	78387.69773	162009.2357	81.00461783
	Ellis	0.003279814	17116.85006	0.003307809	0	0.002422289	0	0.005476558	5433.053271	0.001433662	0	0.000472552	0	0.004672353	0	0.016238427	0	0.005556053	0	0.029837824	21138.51544	43688.42086	21.84421043
	Johnson	0.000286058	1492.895881	0.000526868	0	0.000211267	0	0.000843297	836.5985866	0.000353404	0	0.000101999	0	0.00274283?	0	0.010978701	0	0.000112645	0	0.000512745	363.2524276	2692.746896	1.346373448
	Kaufman	0.006325453	33011.57864	0.006379446	0	0.004671629	0	0.010562096	10478.19745	0.002765	0	0.000911441	0	0.009011105	0	0.031317452	0	0.010715411	0	0.057545265	40767.76758	84257.54368	42.12877184
	Parker	0.000217489	1135.044662	0.000400576	0	0.000160626	0	0.000641157	636.0636209	0.000268692	0	7.75498E-05	0	0.00208537	0	0.008347076	0	0.856434E-05	0	0.000389838	276.1798288	2047.288112	1.023644056
	Rockwall	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Henderson	0.000819895	4278.907463	0.000826893	0	0.000605529	0	0.001369042	1358.167017	0.000358395	0	0.00011814	0	0.001168005	0	0.004059317	0	0.001388914	0	0.007458924	5284.252136	10921.32662	5.460663308
	Hood	0.01252711	65377.08928	0.012634039	0	0.009251829	0	0.020917482	20751.32661	0.005475887	0	0.001805044	0	0.017845854	0	0.062021991	0	0.021221112	0	0.113964315	80737.67115	166866.087	83.43304351
	Hunt	0.006187558	32291.92992	0.006240374	0	0.004569788	0	0.010331844	10249.77392	0.002704724	0	0.000891572	0	0.008814664	0	0.030634735	0	0.010481817	0	0.056290795	39879.0348	82420.73864	41.21036932
El Paso Area	El Paso	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Antonio Area	Bexar	0.033413751	174381.3057	0.051775843	0	0.024677545	0	0.090663423	89943.24864	0.001141841	0	0.143571754	0	0.046873844	0	0.004669544	0	0.000519582	0	0.002503865	1773.85565	266098.41	133.049205
	Comal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Guadalupe	0.002000467	10440.13517	0.076378745	0	0.001477434	0	0.133848731	132785.5183	0.001237133	0	0.003554796	0	0.00161766	0	0.001855699	0	0.000401718	0	0.001835165	1300.116919	144525.7704	72.26288519
	Wilson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Austin Area	Bastrop	0.004502334	23496.99821	0.171901148	0	0.003325174	0	0.301245466	298852.5564	0.002784342	0	0.008000571	0	0.002389654	0	0.004176513	0	0.000904124	0	0.004130298	2926.096684	325275.6513	162.6378256
	Caldwell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hays	0.002458599	12831.05657	0.093870431	0	0.001815785	0	0.164501762	163195.0611	0.001520452	0	0.004368889	0	0.001304924	0	0.002280677	0	0.000493717	0	0.00225544	1597.859937	177623.9776	88.81198878
	Travis	0.000510007	2661.649351	0.299602906	0	0.000376663	0	0.033939476	33669.88179	0.000334709	0	0.000906121	0	0.000271344	0	0.000473247	0	0.000103227	0	0.000467336	331.0826007	36662.61374	18.33130687
	Williamson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North East Texas Area	Gregg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Harrison	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rusk	0.000685965	3579.946607	0.000691182	0	0.000506616	0	0.001145408	1136.310015	0.000299851	0	9.88414E-05	0	0.000977211	0	0.003396227	0	0.001162035	0	0.006240507	4421.067917	9137.324539	4.568662269
	Smith	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upshur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corpus Christi Area	Nueces	0.22756873	1187646.734	0.004556851	0	0.168069652	0	0.007612767	7552.29595	0.001680888	0	0.001626796	0	0.046792036	0	0.007246366	0	0.001609426	0	0.008283395	5868.34572	1201067.376	600.5336879
	San Patricio	0.050313351	262577.7986	0.001007479	0	0.037158653	0	0.001683113	1669.74311	0.000371629	0	0.00035967	0	0.010345288	0	0.001602105	0	0.000355829	0	0.001831382	1297.437217	265544.9402	132.7724701
Victoria Area	Victoria	0.021836736	113962.6161	0.002215582	0	0.016127403	0	0.003612695	3583.998225	0.001199621	0	0.000555389	0	0.52545648	0	0.032412721	0	0.000476855	0	0.002254849	1597.441013	119144.0554	59.57202768
Other ERCOT counties	Andrews	2.47421E-05	129.1251817	2.49533E-05	0	1.82731E-05	0	4.13138E-05	40.9855937	1.08153E-05	0	3.56511E-06	0	3.5247E-05	0	0.000122499	0	4.19135E-06	0	0.000225089	159.4636067	329.5743821	0.164787191
	Angelina	0.00031082	1622.122084	0.000313473	0	0.000229554	0	0.000519	514.8773911	0.000135867	0	4.47864E-05	0	0.000442787	0	0.001538876	0	0.000526534	0	0.002827658	2003.245492	4140.244967	2.070122483
	Bosque	0.000595392	3107.259476	0.000599604	0	0.000439723	0	0.001755208	1741.266031	0.000735562	0	0.000227981	0	0.000853837	0	0.002934455	0	0.001067206	0	0.005167208	756.0604607	5804.585968	2.902292984
	Brazos	0.001939725	10123.13205	0.003572622	0	0.001432574	0	0.005718288	5672.865783	0.002396384	0	0.000691644	0	0.018598805	0	0.074445136	0	0.003476856	0	0.003476856	2463.167282	18259.16511	9.129582557
	Calhoun	0.082699809	431597.7756	0.001655988	0	0.061077496	0	0.002766524	2744.548559	0.000610844	0	0.000591187	0	0.0170045	0	0.002633372	0	0.000584875	0	0.003010234	2132.591188	436474.9154	218.2374577
	Cameron	0.048371747	252444.821	0.000968599	0	0.297964476	0	0.001618161	1605.307323	0.000357288	0	0.00034579	0	0.009946061	0	0.001540279	0	0.000342098	0	0.001760709	1247.368803	255297.4972	127.6487486
	Cherokee	0.003503899	18286.31766	0.003533889	0	0.00258778	0	0.00585077	5804.25581	0.001531635	0	0.000550488	0	0.00419518	0	0.017347879	0	0.005935657	0	0.031876422	22582.75366	46673.32713	23.33666356
	Coke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coleman	0.001298787	6778.17201	2.6007E-05	0	0.000959212	0	4.34478E-05	43.10268327	9.59321E-06	0	9.2845E-06	0	0.000267053	0	4.13567E-05	0	4.72752E-05	0	33.49199351	6854.766687	3.427383344	
	Crockett	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ector	0.00353574?	18452.53138	0.003565928	0	0.002611307	0	0.005903911	5857.013668	0.001545556	0	0.00050947	0	0.005036951	0	0.017505563	0	0.00598961	0	0.032166163	22788.01989	47097.56494	23.54878247
	Fannin	0.007056315	36825.83767	0.007116546	0	0.005211403	0	0.011782473	11688.88052	0.003084477	0	0.001016752	0	0.010052276	0	0.034935966	0	0.011953503	0	0.064194222	45478.20046	93992.91865	46.99645933
	Fayette	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Freestone	0.003677179	19190.63264	0.003708855	0	0.002715767	0	0.006140067	6091.294216	0.001607239	0	0.000529819	0	0.005238429	0	0.018205789	0	0.006229194	0	0.033452809	23699.54068	48981.46754	24.49073377
	Frio	0.008588335	44821.21777	0.008671383	0	0.006342868	0	0.001420864	1409.577723	0.000471808	0	0.000218433	0	0.206660746	0	0.012747844	0	0.000887548	0	0.000886827	628.2696376	46859.06514	23.4295325?
	Grimes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hardeman	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Haskell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hidalgo	0.188527456	983896.238	0.003775086	0	0.139235931	0	0.006306735	6256.637904	0.001392518	0	0.001347706	0	0.0387644?	0	0.006003193	0	0.001333316	0	0.006862311	4861.583088	995014.459	497.5072295
	Howard	0.000555113	2897.050917	0.000559851	0	0.000409976	0	0.000926915	919.5522535	0.000242053	0	7.99868E-05	0	0.000790802	0	0.002748377	0	0.00094037	0	0.005050094	3577.723432	7394.326602	3.697163301
	Jack	0.002121449	11071.51883	0.002139557	0	0.001566784	0	0.003542346	3514.208201	0.000927334	0	0.000305682	0	0.00302217	0	0.010503338	0	0.003593766	0	0.019299698	13672.81193	28258.53896	14.12926948
	Jones	0.040718722	212504.8438	0.008615354	0	0.030072592	0	0.013626147	1351.327314	0.000300676	0	0.002910282	0	0.008372468	0	0.001296587	0	0.002879774	0	0.001482142	1050.019214	214906.1903	107.4530952
	Lamar	0.000950838	4962.2787	0.000958954	0	0.000702236	0	0.001587687	1575.075721	0.000415633	0	0.000137007	0	0.001354543	0	0.004707619	0	0.001610734	0	0.008650166	6128.183898	12665.53832	6.332769159
	Limestone	0.000719757	3756.301635	0.000891528	0	0.000531572	0	0.000300183	297.7986379	0.00545518	0	0.001239347	0	0.000497945	0	0.00031596	0	0.000380962	0	0.000523178	370.6446165	4424.744889	2.212372444
	Llano	0.001238174	6461.84233	0.047274044	0	0.000914447	0	0.082844655	82186.5875	0.000765714	0	0.002200214	0	0.000657172	0	0.001148571	0	0.000248641	0	0.001135861	804.6974871	89453.12732	44.72656366
	McLennan	0.024543117	128040.8858	0.024743738	0	0.018119687	0	0.040966943	40641.42758	0.010724513	0	0.003535175	0	0.034951066	0	0.121469933	0	0.041561501	0	0.22319888	158124.5616	326806.865	163.4034325
	Milam	0.002245405	11718.42816	0.002264571	0	0.001658332	0	0.003749326	3719.543541	0.000981518	0	0.000323543	0	0.003198756	0	0.011117048	0	0.00380375	0	0.0204273?	14471.71494	29909.68664	14.95484332
	Mitchell	0.014943169	77986.13428	0.015070721	0	0.011036196	0	0.024951762	24753.56063	0.006532002	0	0.002153177	0	0.02128772	0	0.07398395	0	0.025313952	0	0.135944204	96309.25655	199048.9515	99.52447574
	Nolan	0.000564654	2946.842154	0.000569473	0	0.000417022	0	0.000942846	935.3564784	0.000246823	0	8.13615E-05	0	0.000804394	0	0.002795613	0	0.000956532	0	0.005136889	3639.213299	7521.411931	3.760705965
	Palo Pinto	0.003269998	16736.83961	0.005906759	0	0.002368511	0	0.009454199	9379.097166	0.003962076	0	0.001147513	0	0.030749889	0	0.123062587	0	0.001262858	0	0.005748375	4072.418802	30188.35458	15.09417729
	Pecos	4.09677E-05	213.8041112	4.13174E-05	0	3.02565E-05	0	6.84069E-05	67.86351291	1.79079E-05	0	5.90308E-06	0	5.83617E-05	0	0.000202832	0	6.93999E-05	0	0.0003727	264.0381548	545.705779	0.272852889
	Presidio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Robertson	0.000737708	3849.984922	0.000835099	0	0.00054483	0	0.000735911	730.071384	0.003149673	0	0.000730875	0	0.000706886	0	0.002413?	0	0.001866309	0	0.019163251?	0	0.003397737	2407.116702	6987.173008	3.493586504
	Taylor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Titus	0.005696437	29728.84386	0.005745061	0	0.004207073	0	0.009511781	9436.225373	0.002490043	0	0.000820806	0	0.008115023	0	0.028203184	0	0.00964985	0	0.051822854	36713.74247	75878.81171	37.93940585
	Tom Green	0.001482448	7736.67185	2.96846E-05	0	0.001094854	0	4.95918E-05	49.1978244	1.09498E-05	0	1.05974E-05	0	0.000304817	0	4.72049E-05	0	5.39604E-05	0	38.22808907	7824.097764	3.912048882	
	Upton	3.11661E-05	162.6512959	3.14322E-05	0	2.30176E-05	0	5.20405E-05	51.62710973	1.36234E-05	0	4.49076E-06	0	4.43986E-05	0	0.000154304	0	5.27959E-05	0	0.000283531	200.8668018	415.1452075	0.207572604
	Ward	0.018559529	96859.36878	0.01871795	0	0.013707039	0	0.030990277	30744.10958	0.008112796	0	0.002674262	0	0.026439509	0	0.091888626	0	0.03144012	0	0.16884373	119616.8253	247220.3036	123.6101518
	Webb	0.020014327	104451.7425	0.000400768	0	0.014781473	0	0.000669531	664.2130601	0.000147832	0	0.000143074	0	0.000415289	0	0.000637307	0	0.000141547	0	0.000728512	516.1121723	105632.0677	52.81603385
	Wharton	0.00014434	753.2870175	0.000178787	0	0.000106601	0	6.01986E-05	59.7204031	0.001093979	0	0.00024853?	0	9.98576E-05	0	6.33625E-05	0	0.000104918	0	74.32890243	887.3363231	0.443668162	
	Wichita	0.003207633	1083.606275	0.000209405	0	0.000153346	0	0.000435403	343.9472141	0.076121E-05	0	2.99181E-05	0	0.00029579	0	0.000351734	0	0.000188925	0	1.338.20346	2765.756948	1.382878474	
	Wilbarger	0.028616818	149346.8393	0.000573026	0	0.021134796	0	0.000957307	949.7028847	0.000211372	0	0.00020457	0	0.005884109	0	0.000911232	0	0.000202386	0	0.001041639	737.9457712	151034.4879	75.51724397
	Wise	0.002844488	14844.9497	0.002882008	0	0.002100781	0	0.00476997	4732.080751	0.001256075	0	0.000413241	0	0.004181914	0	0.014614274	0	0.004797945	0	0.025761411	18250.59318	37827.62363	18.91381181
	Young	0.006235856	32543.98965	0.006289085	0	0.004605458	0	0.010412491	10329.78014	0.002725836	0	0.000898531	0	0.003883469	0	0.030873859	0	0.010563634	0	0.056730171	40190.31687	83064.08665	41.53204332
	Total	1.121837219	5854698.535	1.172570094	0	1.090766584	0	1.189130767	1179685.041	1.629360006	0	1.542362643	0	1.359385821	0	1.231460808	0	1.228106085	0	1.528786947	1083064.448	8117448.024	4058.724012
					0																		
Energy Savings by PCA (MWh)		5218848.541				0		992056.6131		0		0		0		0		0		708446.9486			

Table 5-5: OSD NOx Reductions using the 1999 Base Year and the 2007 eGrid (25%).

Area	County	American Electric Power - West (ERCOT) /PCA	NOx Reductions (lbs)	Austin Energy/PCA	NOx Reductions (lbs)	Brownsville Public Utils Board/PCA	NOx Reductions (lbs)	Lower Colorado River Authority /PCA	NOx Reductions (lbs)	Reliant Energy HL&P/PCA	NOx Reductions (lbs)	San Antonio Public Service Bd/PCA	NOx Reductions (lbs)	South Texas Electric Coop INC/PCA	NOx Reductions (lbs)	Texas Municipal Power Pool/PCA	NOx Reductions (lbs)	Texas-New Mexico Power Co/PCA	NOx Reductions (lbs)	TXU Electric/PCA	NOx Reductions (lbs)	Total Nox Reductions (lbs)	Total Nox Reductions (Tons)
Houston-Galveston Area	Brazoria	0.00957217	115.6461881	0.011806715	0	0.007069474	0	0.004263638	7.853846218	0.071001767	0	0.016140391	0	0.006781035	0	0.005179719	0	0.126288049	0	0.008771659	11.8005978	135.3006321	0.067650316
	Chambers	0.021881395	264.3601288	0.027103415	0	0.016160386	0	0.009125896	16.81038259	0.165843463	0	0.037677498	0	0.01513807	0	0.009605529	0	0.011581666	0	0.015905217	21.39744402	302.5679554	0.151283978
	Fort Bend	0.055695513	672.8854596	0.068987309	0	0.041133619	0	0.023228475	42.78807878	0.422127404	0	0.095901908	0	0.038531479	0	0.024449302	0	0.029479235	0	0.040484129	54.46369323	770.1372317	0.385068616
	Galveston	0.027555985	332.9176972	0.033893644	0	0.020351324	0	0.012791501	23.56262192	0.201446635	0	0.045812515	0	0.019823685	0	0.01677514	0	0.594656509	0	0.028709453	38.62310615	395.1034253	0.197551715
	Harris	0.077360573	934.6319373	0.09582776	0	0.057134232	0	0.032264145	59.43226205	0.586331222	0	0.1332069	0	0.053519883	0	0.033959864	0	0.040946397	0	0.056232096	75.64958699	1069.713786	0.534856893
	Liberty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Montgomery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Waller	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beaumont/ Port Arthur Area	Hardin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jefferson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Orange	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dallas/ Fort Worth Area	Collin	0.001763649	21.30752807	0.003151138	0	0.001302533	0	0.000505143	9.30263003	0.002085751	0	0.00060408	0	0.015958397	0	0.063788818	0	0.000846136	0	0.004013208	5.399007229	36.00916533	0.018004583
	Dallas	0.005045553	60.95785869	0.005305276	0	0.003726366	0	0.008757288	16.13138464	0.002413087	0	0.000782263	0	0.009310387	0	0.033672029	0	0.008209179	0	0.044022182	59.1965661	136.2858094	0.068142905
	Denton	0.000635758	7.680909503	0.001170951	0	0.000469535	0	0.001874207	3.452388411	0.000785431	0	0.000226691	0	0.000959882	0	0.024399888	0	0.000259035	0	0.001139562	1.533064265	12.6663621	0.006333181
	Tarrant	0.015572243	188.136092	0.015705165	0	0.011500796	0	0.026002176	47.8973844?	0.006806985	0	0.002243821	0	0.022183886	0	0.077098512	0	0.026379614	0	0.141667156	190.5862051	426.6196815	0.213309841
	Ellis	0.003502824	42.31937146	0.003532723	0	0.002586991	0	0.005848935	10.77404757	0.001531165	0	0.000504725	0	0.004990048	0	0.017342555	0	0.009933836	0	0.031866639	42.87050041	95.96391945	0.04798196
	Johnson	0.000337176	4.073592993	0.000621017	0	0.00024902	0	0.000993991	1.830984369	0.000416556	0	0.000120226	0	0.003232969	0	0.012940552	0	0.000132774	0	0.00060437	0.813065151	6.717642513	0.003358821
	Kaufman	0.000492753	78.44220437	0.000548174	0	0.004795187	0	0.010841451	19.97052443	0.002838131	0	0.00093554?	0	0.009249437	0	0.032145758	0	0.010999882	0	0.059067263	79.46376419	177.8764493	0.088938246
	Parker	0.000475952	5.750210321	0.000876616	0	0.000351511	0	0.0014031	2.584584477	0.000580002	0	0.000169709	0	0.0045636	0	0.012826665	0	0.000187421	0	0.000853118	1.147708088	9.482502886	0.004741251
	Rockwall	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Henderson	0.000950271	11.48070184	0.000958382	0	0.000701818	0	0.001586741	2.922860702	0.000415385	0	0.000136926	0	0.001353736	0	0.004704812	0	0.001609773	0	0.00864501	11.63021604	26.03377858	0.013016889
	Hood	0.012327882	148.9393339	0.012433111	0	0.009104469	0	0.020564881?	37.91852	0.0053888	0	0.003177637	0	0.012569209	0	0.061035609	0	0.020885381	0	0.111251856	150.8789841	337.7366308	0.168868319
	Hunt	0.006351211	76.73217309	0.006405424	0	0.004690653	0	0.010605108	19.53516923	0.00277626	0	0.000915153	0	0.0090478	0	0.031444984	0	0.010759047	0	0.057779603	77.73146302	173.9988053	0.086999403
El Paso Area	El Paso	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Antonio Area	Bexar	0.03112814	376.0743767	0.048234164	0	0.0229895	0	0.084461674	155.582872	0.001063735	0	1.065346769	0	0.043667482	0	0.004350128	0	0.000484041	0	0.002332591	3.138056811	534.7953054	0.267397653
	Comal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Guadalupe	0.002007611	24.25495194	0.076651484	0	0.00148271	0	0.134326688	247.4368653	0.00124155	0	0.00356748	0	0.001065557	0	0.001862326	0	0.000403153	0	0.001841718	2.477681131	274.1694983	0.137084749
	Wilson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Austin Area	Bastrop	0.004469515	53.9984506	0.170648096	0	0.003300936	0	0.299049574	550.8651338	0.002764046	0	0.007942252	0	0.002372235	0	0.004146069	0	0.000897533	0	0.004100519	5.516025862	610.3796102	0.305189805
	Caldwell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hays	0.002469353	29.8334921	0.094281013	0	0.00182727	0	0.165221279	304.3463365	0.001571102	0	0.004387998	0	0.001310631	0	0.002290653	0	0.000495876	0	0.002265306	3.0476377	337.2273663	0.168613683
	Travis	0.000507609	6.13268093	0.298194277	0	0.000374892	0	0.033779905	62.22437116	0.000333135	0	0.00091	0	0.000269863	0	0.000469526	0	0.000102841	0	0.000465139	0.625755383	68.98280747	0.034491404
	Williamson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North East Texas Area	Gregg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Harrison	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rusk	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Smith	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upshur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corpus Christi Area	Nueces	0.223524525	2700.512057	0.00447587	0	0.165082827	0	0.007477478	13.77390988	0.001651016	0	0.001597898	0	0.045960479	0	0.007117588	0	0.001583824	0	0.008136188	10.94569242	2725.231659	1.36261583
	San Patricio	0.055330886	668.4802255	0.001107949	0	0.040864326	0	0.001850962	3.409570552	0.00004869	0	0.000395538	0	0.011376998	0	0.007676876	0	0.000391115	0	0.002014018	2.709478344	674.5592744	0.337299637
Victoria Area	Victoria	0.020604752	248.9363584	0.002090584	0	0.015217528	0	0.003408874	6.279327046	0.001131941	0	0.000524055	0	0.495811308	0	0.030584062	0	0.000449952	0	0.002127635	2.862328397	258.0780139	0.129039007
Other ERCOT counties	Andrews	2.56527E-05	0.309922707	2.58716E-05	0	1.89456E-05	0	4.28342E-05	0.07890292	1.12134E-05	0	3.69632E-06	0	3.65442E-05	0	0.000127007	0	4.3456E-05	0	0.000233373	0.313958858	0.702784486	0.000351392
	Angelina	0.00032149	3.884084159	0.000324234	0	0.000237435	0	0.000536817	0.988845204	0.000140531	0	4.63239E-05	0	0.000457988	0	0.001591705	0	0.000544609	0	0.002924729	3.934666933	8.807596296	0.004403798
	Bosque	0.000939453	11.3499977	0.001730301	0	0.000693828	0	0.002769496	5.101558279	0.001160623	0	0.000334979	0	0.009007821	0	0.036055459	0	0.003699939	0	0.001683919	2.265393045	18.71695103	0.009358479
	Brazos	0.001913926	23.12310548	0.003525105	0	0.00141352	0	0.005642234	10.39329279	0.002364512	0	0.000682445	0	0.018351436	0	0.073454996	0	0.00075367	0	0.003430612	4.615235565	38.13163384	0.019065817
	Calhoun	0.088525246	1069.517959	0.001772635	0	0.065379841	0	0.0029614	5.455055811	0.000653873	0	0.000632831	0	0.01820231	0	0.002818869	0	0.000626074	0	0.003222277	4.334961065	1079.307976	0.539653988
	Cameron	0.054672288	660.5233653	0.001094762	0	0.285623104	0	0.001828931	3.368986739	0.000403825	0	0.00039083	0	0.011241561	0	0.001740904	0	0.000386657	0	0.001990046	2.677227667	666.5695797	0.3328479
	Cherokee	0.003512996	42.44225867	0.003542982	0	0.002594504	0	0.005865919	10.80533331	0.001535611	0	0.000506191	0	0.005004538	0	0.017392515	0	0.003959166	0	0.031959174	42.99498799	96.24257997	0.048121299
	Coke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coleman	0.001355099	16.37163582	2.71346E-05	0	0.001000801	0	4.53316E-05	0.083503214	1.00092E-05	0	9.68705E-06	0	0.000278632	0	4.3149BE-05	0	9.58362E-06	0	4.9325E-05	0.066357375	16.52149641	0.008260748
	Crockett	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ector	0.003629264	43.84695605	0.003660242	0	0.002680373	0	0.006060061	11.16295385	0.001586434	0	0.000522944	0	0.005170172	0	0.017968562	0	0.006148027	0	0.033016916	44.41797887	99.42788876	0.049713944
	Fannin	0.007628516	92.16393544	0.007693632	0	0.005633999	0	0.012737922	23.46392658	0.003345899	0	0.001099201	0	0.010867422	0	0.037768948	0	0.012928221	0	0.068399775	93.36419459	208.9920566	0.104496028
	Fayette	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Freestone	0.003774434	45.60083429	0.003806652	0	0.002787588	0	0.006302464	11.609472	0.001649892	0	0.000543862	0	0.005376978	0	0.018687305	0	0.006393948	0	0.034337593	46.19469802	103.4050043	0.051702502
	Frio	0.014763838	178.3693449	0.001497957	0	0.010903753	0	0.002442547	4.499300377	0.000811065	0	0.000375499	0	0.355261637	0	0.021914272	0	0.000322402	0	0.001524506	2.050932391	184.9195776	0.092459789
	Grimes	0.000554424	6.698277477	0.001021149	0	0.000409467	0	0.001634436	3.010718395	0.000684949	0	0.00019769	0	0.005316025	0	0.022378368	0	0.000218322	0	0.000993776	1.336936704	11.04593258	0.005522964
	Hardeman	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Haskell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hidalgo	0.239736996	2896.383052	0.004800509	0	0.177056459	0	0.008019827	14.77294613	0.001770766	0	0.001713782	0	0.049294041	0	0.007633834	0	0.001695483	0	0.008726314	11.73959507	2922.896594	1.461447797
	Howard	0.000585081	7.068655796	0.000590075	0	0.000432108	0	0.000976955	1.799602196	0.000255752	0	8.43049E-05	0	0.000833494	0	0.002896748	0	0.000991136	0	0.005227223	7.160711531	16.02896952	0.008014488
	Jack	0.002177568	26.30817363	0.002196145	0	0.001606224	0	0.003650237	6.897772384	0.000591861	0	0.000231704	0	0.001910103	0	0.007811137	0	0.003688816	0	0.019810157	26.65078732	59.65673226	0.029828367
	Jones	0.042500124	513.4653402	0.000851025	0	0.031388236	0	0.00142174	2.618920106	0.000313918	0	0.000303816	0	0.007387755	0	0.001353312	0	0.000300572	0	0.001546985	2.081173334	518.1653337	0.259082717
	Lamar	0.00107998	13.04778643	0.001089199	0	0.000797614	0	0.001803327	3.321823242	0.000472084	0	0.000155616	0	0.001538517	0	0.005347007	0	0.001829503	0	0.00982503	13.21770891	29.58731858	0.014793659
	Limestone	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Llano	0.00124346	15.02286366	0.047475864	0	0.000918351	0	0.083198331	153.2557269	0.000768983	0	0.002209607	0	0.00065997	0	0.000249702	0	0.001134774	0	0.001140715	1.534608929	169.8131996	0.0849066
	McLennan	0.023031368	278.2535296	0.023227961	0	0.017096962	0	0.038457253	70.84029518	0.01006754	0	0.003318614	0	0.032809997	0	0.114028801	0	0.039015483	0	0.209525912	281.8772502	630.971075	0.315485537
	Milam	0.001652492	19.96458702	0.001666598	0	0.001220439	0	0.002759294	5.082764771	0.000722342	0	0.000238109	0	0.002354105	0	0.008181524	0	0.002799346	0	0.015033406	20.22458762	45.27193941	0.02263597
	Mitchell	0.016961453	204.9198328	0.017106233	0	0.012526789	0	0.028321847	52.17034071	0.00741424	0	0.002443993	0	0.024162925	0	0.083976519	0	0.028732956	0	0.154305373	207.5885221	464.6786956	0.232339348
	Nolan	0.000603273	7.288442771	0.000608422	0	0.000445544	0	0.001031737	1.855557554	0.000263704	0	8.69262E-05	0	0.00089941	0	0.003268617	0	0.001027358	0	0.005488224	7.383360833	16.52736118	0.008263681
	Palo Pinto	0.003074879	37.14916138	0.00566337	0	0.002270935	0	0.00906471	16.69767547	0.003798781	0	0.001096403	0	0.029483083	0	0.118011463	0	0.005511559	0	0.001210832	7.414753652	61.26159051	0.030630795
	Pecos	4.22618E-05	0.51058581	4.26225E-05	0	3.12122E-05	0	7.05678E-05	0.129989544	1.84736E-05	0	6.08954E-06	0	6.02052E-05	0	0.000209239	0	7.15921E-05	0	0.000384473	0.517235214	1.157810568	0.000578905
	Presidio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Robertson	0.000359257	4.340370084	0.000406685	0	0.000265328	0	0.000358385	0.660164937	0.001533867	0	0.00035593	0	0.000370532	0	0.000908875	0	0.09332343	0	0.00165467	2.226043188	7.22657821	0.003613289
	Taylor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Titus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Tom Green	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upton	3.2238E-05	0.389482869	3.25131E-05	0	2.38092E-05	0	5.38302E-05	0.099158064	1.40919E-05	0	4.6452E-06	0	4.59255E-05	0	0.000159611	0	5.46116E-05	0	0.000293282	0.394555139	0.883196073	0.000441598
	Ward	0.019807626	239.3058742	0.019976?	0	0.014628815	0	0.033074321	60.92464949	0.008653368	0	0.002954101	0	0.028217522	0	0.098067981	0	0.033554415	0	0.180198187	242.4223759	542.6528996	0.27132645
	Webb	0.014180046	171.3162532	0.000283942	0	0.010472596	0	0.000474359	0.873795259	0.000104738	0	0.000101367	0	0.002915661	0	0.000451529	0	0.000410285	0	0.000516147	0.694377575	172.8844261	0.086442213
	Wharton	0.00015439	1.86526296	0.000191235	0	0.000114024	0	6.43902E-05	0.11861011	0.001170153	0	0.000265844	0	0.000106811	0	6.77744E-05	0	8.17175E-05	0	0.000112223	0.150975338	2.134848409	0.001067424
	Wichita	0.000219843	2.656033029	0.000217119	0	0.000162364	0	0.000367089	0.676196842	9.60984E-05	0	3.16774E-05	0	0.000313184	0	0.001088447	0	0.000372413	0	0.002000002	2.69062278	6.022852666	0.003011426
	Wilbarger	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Wise	0.002918471	35.25951296	0.002955932	0	0.002155421	0	0.004892446	9.012144486	0.001287753	0	0.000423725	0	0.004280539	0	0.014952843	0	0.004924352	0	0.026440527	35.57069887	79.84235632	0.039921178
	Young	0.00549666	66.40791238	0.005543579	0	0.004059529	0	0.009178198	16.90672575	0.002402716	0	0.000792019	0	0.007830425	0	0.027214854	0	0.050005398	0	0.027274854	150.5873867	0.075293693	
	Total	**1.143037355**	**13809.60837**	**1.154658244**	**0**	**1.089429227**	**0**	**1.180868675**	**2175.222565**	**1.539350626**	**0**	**1.443063194**	**0**	**1.48172714**	**0**	**1.269705424**	**0**	**1.151968562**	**0**	**1.517782624**	**2041.887749**	**18026.71869**	**9.013359343**
Energy Savings by PCA (MWh)		12081.50225				0		1842.052898		0		0		0		0		0		1345.309741			

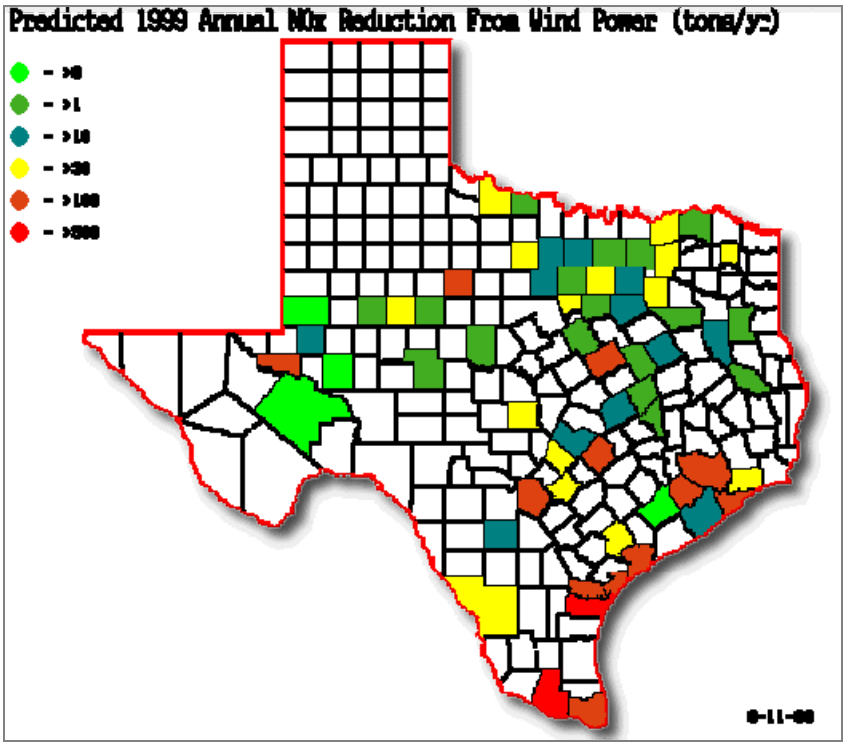


Figure 5-4: 1999 Predicted Annual NOx Reductions from Wind Power in Texas Map.

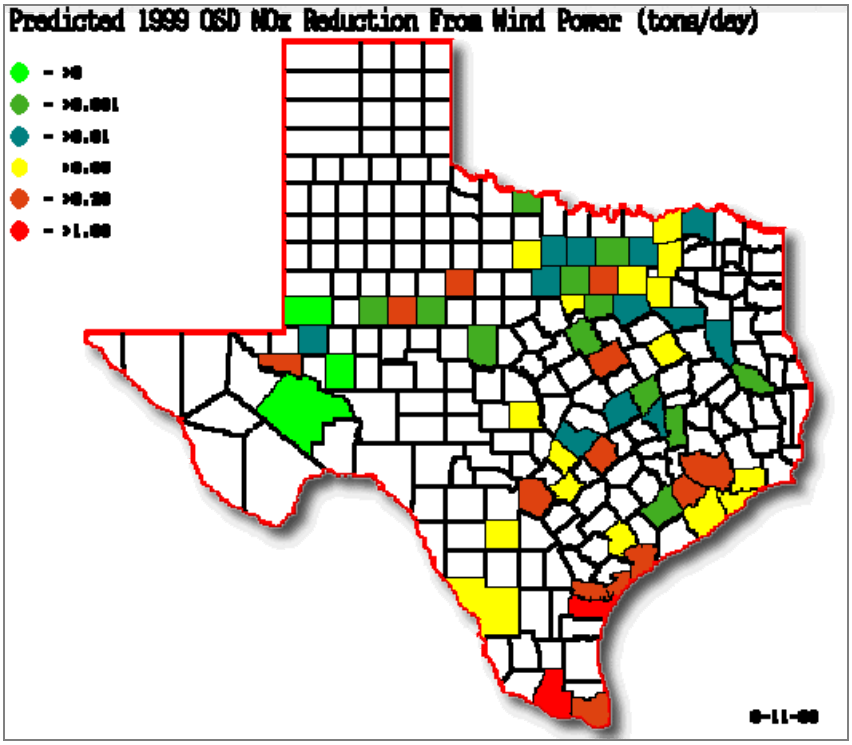


Figure 5-5: 1999 Predicted OSD NOx Reductions from Wind Power in Texas Map.

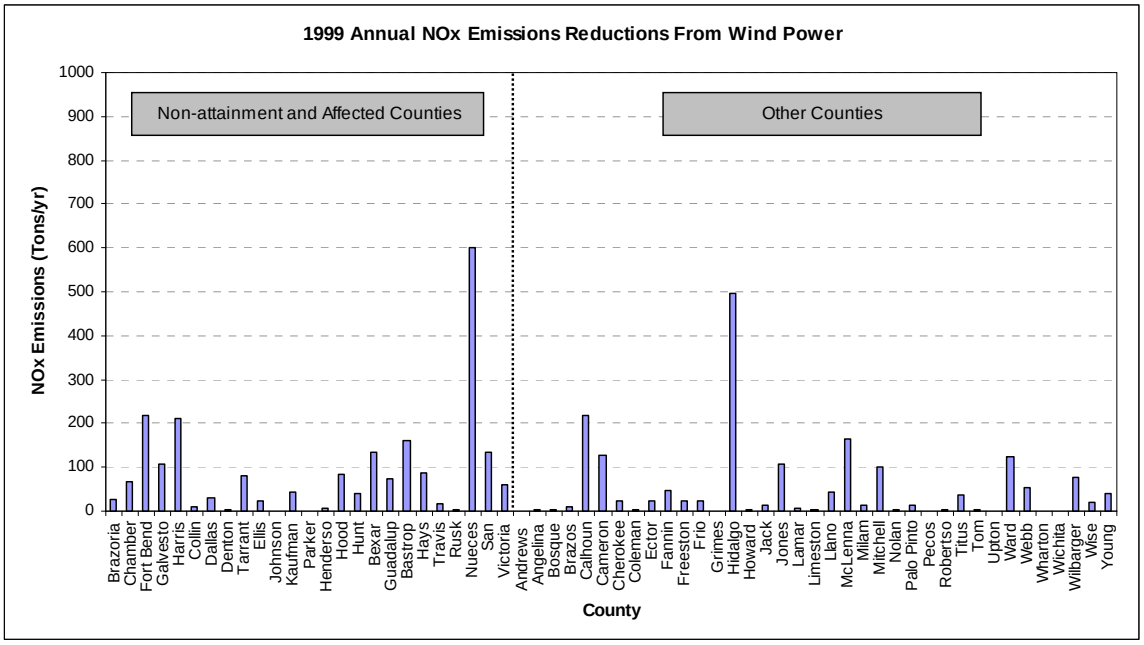


Figure 5-6: 1999 Predicted Annual NOx Reductions from Wind Power.

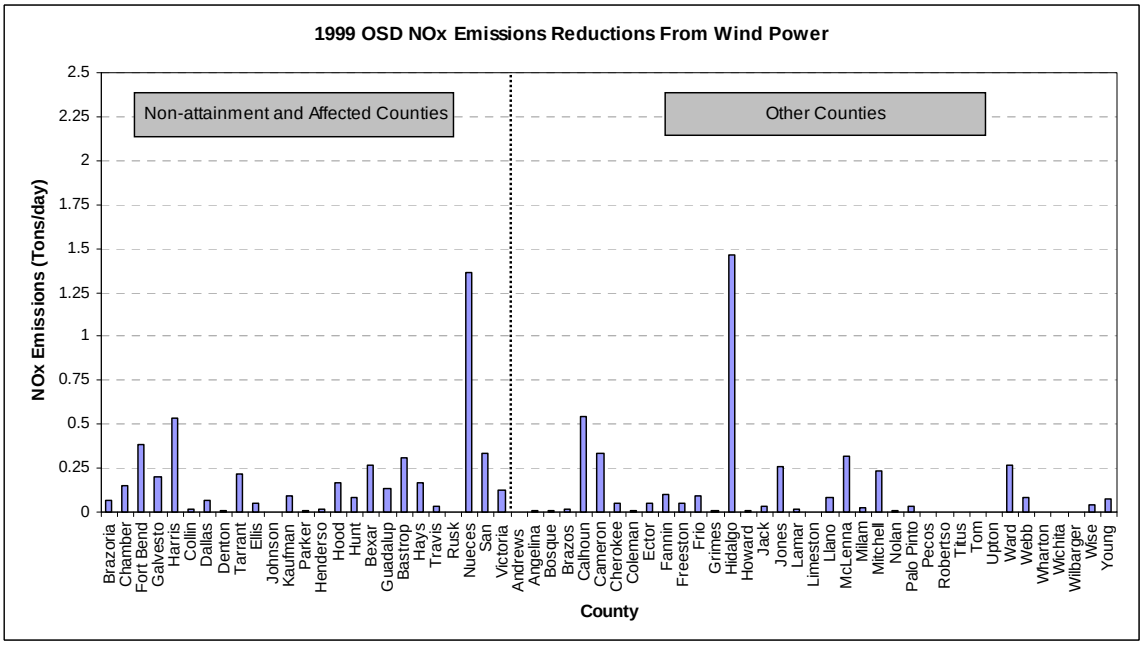


Figure 5-7: 1999 Predicted OSD NOx Reductions from Wind Power.

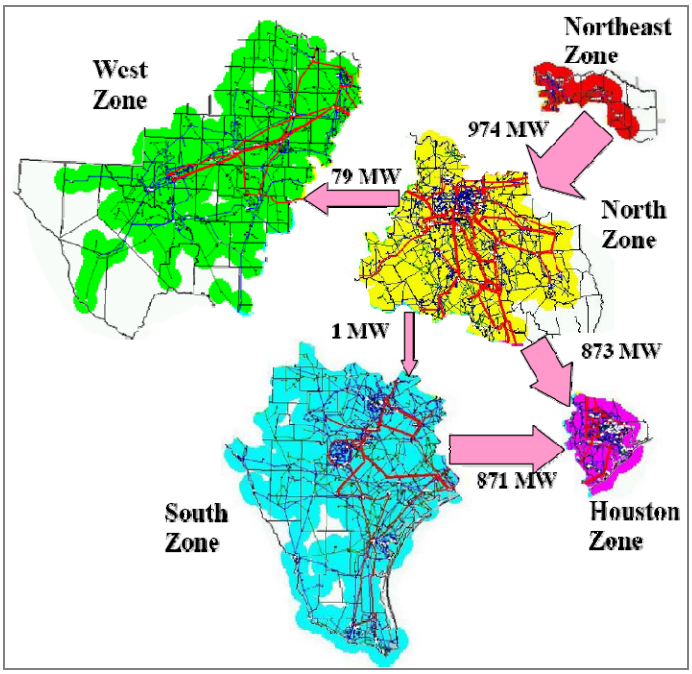


Figure 5-8: Average Modeled Flows on Commercially Significant Constrains for 2006.

5.2 Calculation of NOx Emissions from Wind Power Using Electricity Sales Data

As discussed in the previous section, there is no practical way to identify where or how the electricity consumed by a certain user was generated. We have been investigating some other methods for estimating the emissions reduction from the wind power. If we assume the wind power can be transmitted to anywhere within the ERCOT region, then the generated wind power can also be proportionally assigned to each PCA based on the annual electricity generation/sales data of PCA for the purpose of calculating emissions reduction.

Table 5-6: PCA 1998 Annual Net Generation and 1999 Wind Power Assignment for Each PCA.

PCA	PCA 1998 Annual Net Generation (MWh)	1999 Predicted Wind Power For Each PCA (MWh/yr)	1999 OSD Predicted Wind Power For Each PCA (MWh/day)
American Electric Power - West (ERCOT)/PCA	33,028,932	771,980	1,704
Austin Energy/PCA	3,712,929	86,782	192
Brownsville Public Utils Board/PCA	236,180	5,520	12
Lower Colorado River Authority/PCA	12,037,446	281,349	621
Reliant Energy HL&P/PCA	104,265,741	2,436,986	5,378
San Antonio Public Service Bd/PCA	14,646,928	342,340	755
South Texas Electric Coop Inc/PCA	3,239,094	75,707	167
Texas Municipal Power Pool/PCA	8,804,340	205,782	454
Texas-New Mexico Power Co/PCA	10,258,063	239,760	529
TXU Electric/PCA	105,812,850	2,473,146	5,457
Total	296,042,502	6,919,352	15,269

Table 5-6 summarizes the electricity generation data from each PCA in 1998. According to the proportion of power generation of each PCA, the predicted annual and OSD wind power production in 1999 was

assigned to each power control area, i.e., if more electricity was generated in one PCA, more wind power would be assigned in this PCA. Then the total wind power production in each PCA was input into the corresponding cells in the eGRID table to calculate the total annual and OSD emissions reduction for the entire ERCOT region. The total NOx emissions reductions across all the counties amount to 5,119 tons/yr and 11 tons/day for the Ozone Season Period. The distribution of the NOx emissions reduction in the counties within the ERCOT region is shown in Figure 5-9, Figure 5-10, Figure 5-11and Figure 5-12.

5.3 Observations from Different Methodologies

It is noted that using electricity sales data (method 2) for calculating emissions reduction resulted in a 26% increase for the year of 1999 (from 4,059 tons/yr to 5,119 tons/yr) and a 22% increase in the OSD of 1999 (from 9 tons/day to 11 tons/day) if compared to method 1 (i.e., using interconnection information from the PUCT for assigning wind power to PCAs). This is because in method 1, 75% of wind power produced was assigned to AEP-west power control area while AEP-West has a lower emissions rate (1.12 lbs/MWh) than most of other PCAs in the eGRID. In method 2, the wind power was proportionally assigned to all ten PCAs according to the sales data. Therefore, 35% of wind power was assigned to PCA-Reliant Energy, which has an emissions rate of 1.63 lbs/MWh in the 2007 annual eGRID, and another 36% was assigned to TXU, which has an emission rate of 1.53 lbs/MWh. Hence, the total emissions for both and annual are much higher in method 2. The distribution of emissions reduction among counties also differs in these two methods. In summary, method 1 is more conservative than using electricity sales data and is recommended to be used in this year's report.

The ESL is currently in communication with the EPA and the TCEQ regarding a new version of eGRID for all ERCOT counties in Texas. As the TCEQ moves the base year to more recent years and ERCOT is in the process of moving toward the Nodal market, an updated version of eGRID representing the Texas market in 2000-2007 will need to be created to estimate the emissions reduction from wind power. We will continue our communications with ERCOT, the PUCT and the TCEQ to assure the work is reviewed by our stakeholders.

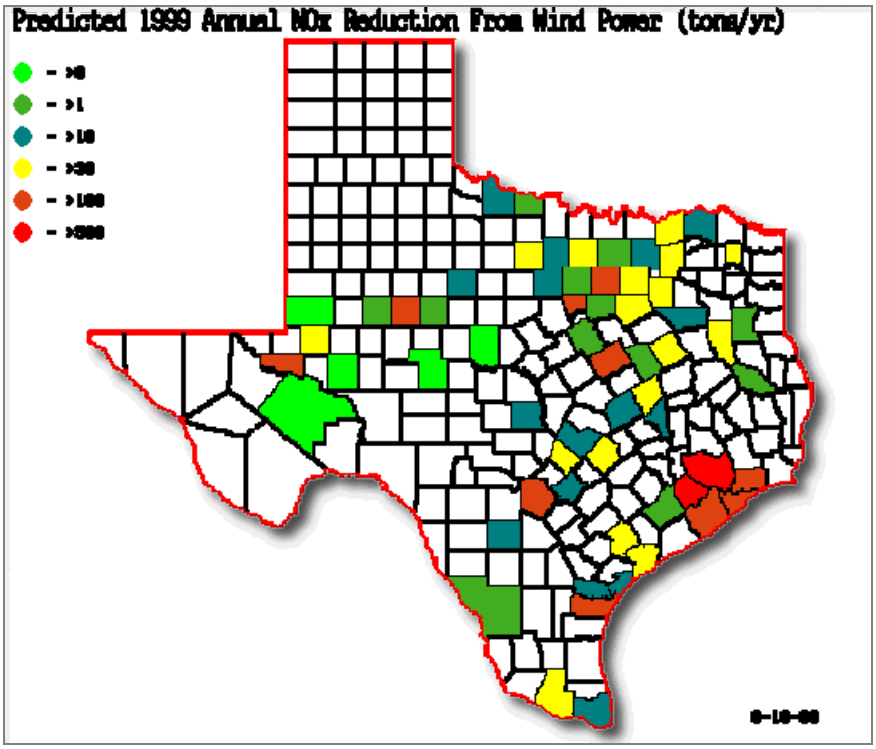


Figure 5-9: 1999 Predicted Annual NOx Reduction from Wind Power Using 1998 Electricity Sales Data in Texas Map.

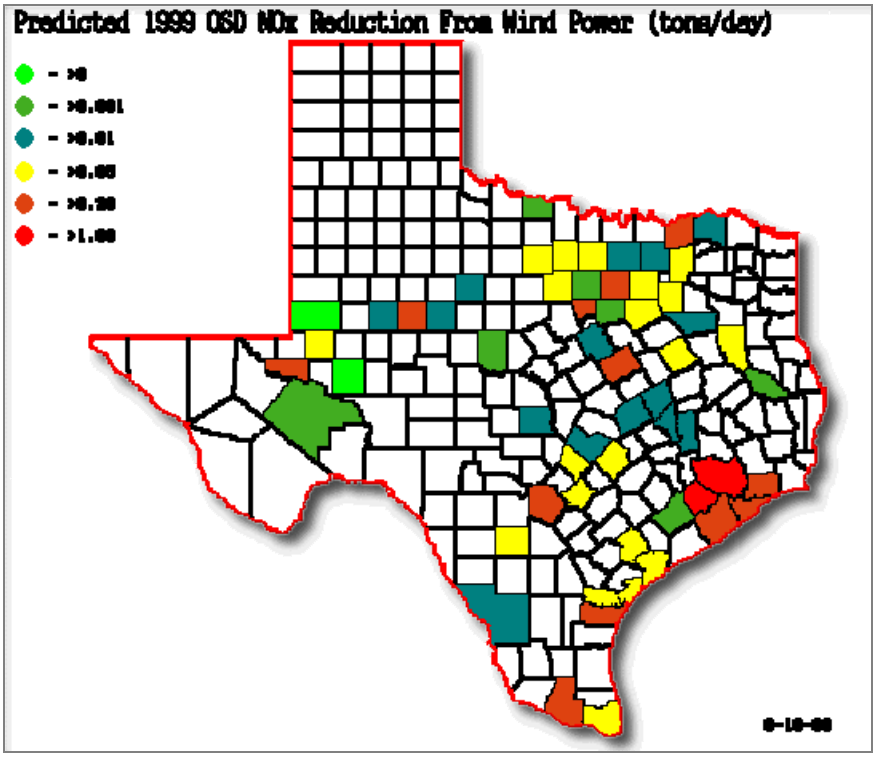


Figure 5-10: 1999 Predicted OSD NOx Reduction from Wind Power Using 1998 Electricity Sales Data in Texas Map.

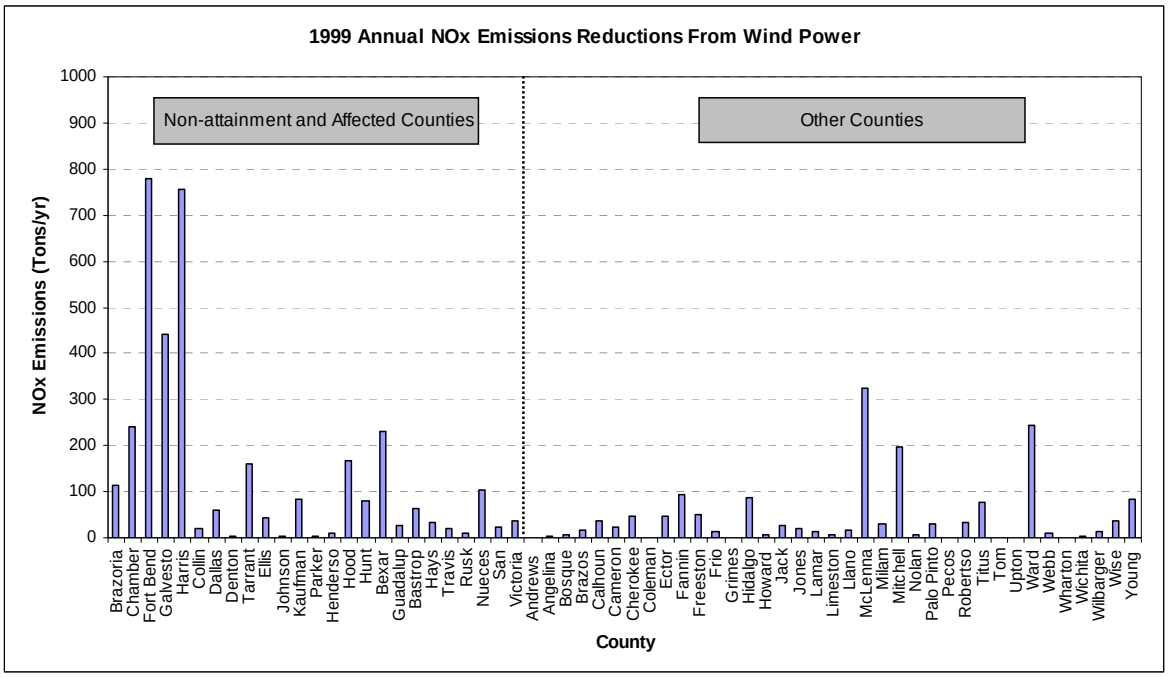


Figure 5-11: 1999 Predicted Annual NOx Reduction from Wind Power Using 1998 Electricity Sales Data.

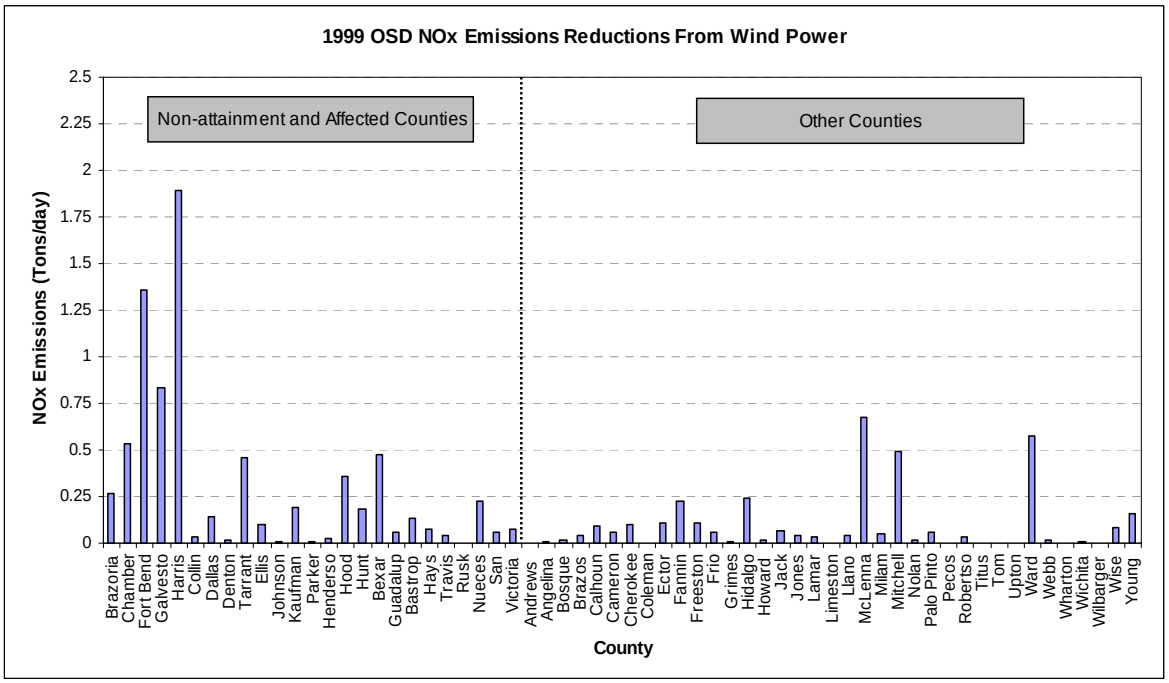


Figure 5-12: 1999 Predicted OSD NOx Reduction from Wind Power Using 1998 Electricity Sales Data.

6 OTHER RENEWABLES

Renewable energy projects throughout the state of Texas were found to determine NOx emissions reduction. Five specific categories were determined to search within, including solar photovoltaic, solar thermal, geothermal, hydroelectric, and Landfill Gas-Fired Power Plants. The criteria for each project to be included in the data collection were that the installation date was after the year 2000 and the project was installed within the state of Texas. However, projects installed before the year 2000, were also included in order to provide a complete record.

6.1 Implementation

As previously reported, this is an updated version of the earlier report published in July 2007. Many newly-located, renewable-energy projects are included in this section in the five main categories.

The information was collected using the following modes:

- Information from the internet- websites of environmental agencies like ERCOT, EIA, NREL which publish information that is available to the general public;
- Information from the websites of manufacturers, distributors, consultants related with renewable energy products; and
- Some information was collected by personally emailing individuals, who were either manufacturers, distributors, or consultants.

It was essentially the same methodology/protocol followed for data collection used in the previous report. In most cases, the information obtained was very limited. They did not contain some system specification data. Therefore, we contacted manufacturers, consultants, and distributors or officers in environmental agencies to collect more information; their responses are also included. Table 6-1 shows the number of new projects in each category that are added in this report.

6.2 Renewable Energy Projects

6.2.1 Solar Photovoltaic

In the case of solar photovoltaic types of projects, we could not find the system specifications and other details of any additional projects other than those specified in the previous report. Some of the websites provided no information, while others gave limited details. By far, Soltrex's website seemed to be the only main source of information for solar photovoltaic systems because it provided online monitoring of all those systems.

Though some websites, like SECO, seem to provide system specification data, they turn out to be links to the Soltrex website in the end. Apart from these sources, another website, Standard Renewable Energy, reports about 50 projects installed in the state of Texas but with very limited details. Meridian Energy Systems and "southwestpv" also provide some 40 old projects. But the details were so limited that they could not be included in this report. The above said entities were contacted for more details but no response was received.

The number of projects per county is presented in Figure 6-1. A summary of the different projects and their outputs of ESL's emissions calculator (*e*CALC) can be found in Table 6-2 and Table 6-3, respectively. The annual and OSD electric savings per county, due to these projects, are presented in Figure 6-6 and Figure 6-7, and the corresponding emissions reductions are shown in Figure 6-8 and Figure 6-9.

6.2.2 Solar Thermal

Apart from the projects reported by Techsun solar, which were included in the previous report, we were able to locate six more projects in this year's report. The source of information is a solar heating equipment

manufacturer – "Alternative Power Solutions." Their website provided some case studies which are included in this information.

The number of projects collected per county is presented in Figure 6-2. A summary of the different projects and their outputs from *e*CALC can be found in Table 6-4 and Table 6-5, respectively. The annual and OSD electric savings per county, due to these projects, are presented in Figure 6-10 and Figure 6-11, and the respective emission reductions are shown in Figure 6-12 and Figure 6-13. The special projects for parabolic solar concentrators are listed in Table 6-6.

6.2.3 Hydroelectric

The previous report included about 28 hydroelectric projects installed in the state of Texas. These details were obtained from the Idaho National Laboratory website. In this report we have located about 17 projects, apart from the previously reported projects.

All hydroelectric projects located and their information is presented in Table 6-7. A Texas map, which shows the location of the different projects per county, is presented in Figure 6-3.

6.2.4 Geothermal

Information provided by "Image Engineering Group," a consultant group, details about 120 different geothermal heat pump projects installed in the state of Texas in different schools and organizations. They have been listed in Table 6-8. However, in-depth details were not available.

Also, FHP manufacturing, a geothermal heat pump manufacturer, provides information about some 50 different projects installed in the state of Texas. This information was also included in the report.

The resulting information can be found in Table 6-8 with a corresponding map in Figure 6-4 which shows the number of projects in different counties.

6.2.5 Landfill Gas-Fired Power Plants

The Environmental Protection Agency (EPA) has a project data base for Landfill Methane Outreach Program (LMOP). This formed the main source of information for the previous report. The information provided by Mr. William Horvath from the Energy Information Agency (EIA) helped in making considerable additions to the number of projects available. We were able to locate and report about 25 new projects. The implemented, candidate, and potential projects are listed in Table 6-9, Table 6-10, and Table 6-11**,** respectively. Figure 6-5 shows the location of these operational projects implemented throughout Texas.

6.3 Results

We were able to considerably increase the number of renewable energy projects identified in the state of Texas to present. Some 261 projects were identified, located and included in the new report (which was not included in the report published in July 2007); the details are found in Table 6-1. This report also includes the emission reduction calculations included in the previous report.

Table 6-1: New Projects Added in This Report.

Renewable Energy Source	No. of New Projects Identified & Reported in July 2008
Solar PV	0
Solar Thermal	6
Landfill Gas	25
Hydro Electric	17
Geo Thermal	203

6.4 References

Haberl, J., Culp, C., Yazdani, B., Gilman, D., Fitzpatrick, T., Muns, S., Verdict, Ahmed, M., Liu, Z., Baltazar-Cervantes, J., Degelman, L., Turner, D. 2006. "Energy Efficiency/Renewable Energy Impact in the Texas Emissions Reduction Plan (TERP), Vol. II-Summary Report, Annual Report to the Texas Commission on Environmental Quality," September 2004-December 2005, *Energy Systems Laboratory Report No. ESL-TR-06-06-08.*

Useful information was obtained from the following websites:

http://www.soltrex.com/systems.cfm?state=tx

http://www.meridiansolar.com/portfolio_commercial/commerical.html

http://www.sre3.com/projectGallery.jsp

http://www.sre3.com/index.jsp

http://apowersolutions.com/pdf/Commercial%20Solar%20Pool%20Heating%20Case%20Studies.pdf

http://www.eia.doe.gov/cneaf/electricity/page/eia860.html

http://www.iegltd.com/project.refer.geo.master.pdf

http://www.iegltd.com/html/information.html

http://geoheat.oit.edu/state/tx/tx.htm

http://data.memberclicks.com/site/treia/Maria_RichardsSchools.pdf

Table 6-2: Solar Photovoltaic Cell Projects: Data and Information.

Project No.	Solar Project	City/Town	County	County for ECALC	Date	PV Modules	Capacity(kW)	Total Area (sqft)	Slope	Azimuth (South=180)
1	La Grange Intermediate School	La Grange, TX	Fayette	Bastrop	05/01/05	GE Energy GEPV-050-M	1	6.07	30	180
2	Giddings Middle School	Giddings, TX	Lee	Bastrop	6/5/2008	GE Energy GEPV-050-M	1	121.4	30	180
3	Schulenburg Elementary School	Schulenburg, TX	Fayette	Bastrop	6/5/2008	GE Energy GEPV-050-M	1	121.4	30	180
4	Smithville Junior High School	Smithville, TX	Bastrop	Bastrop	6/5/2008	GE Energy GEPV-050-M	1	121.4	30	180
5	Bastrop Intermediate School	Bastrop, TX	Bastrop	Bastrop	5/7/2008	Sharp Electronics NE-170-U1	1.02	84	35	180
6	Del Rio High School	Del Rio, TX	Kinney	Bexar	7/1/1999	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
7	Uvalde Junior High School	Uvalde, TX	Uvalde	Bexar	7/1/1999	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
8	John Jay High School	San Antonio, TX	Bexar	Bexar	12/1/2008	Siemens SP 75	0.9	81.84	60	180
9	Eagle Pass High School - CC Winn Campus	Eagle Pass, TX	Maverick	Bexar	2/2/2008	Siemens SP 75	0.9	81.84	25	180
10	James Madison High School	San Antonio, TX	Bexar	Bexar	2/2/2008	Siemens SP 75	0.9	81.84	25	180
11	City Public Services of San Antonio, Northside	San Antonio, TX	Bexar	Bexar	7/2/2008	MSX-120	17.28	1699.2	30*	180*
12	East Central ISD	San Antonio, TX	Bexar	Bexar	11/3/2008	Shell SP-140-PC	1.12	113.92	60	180
13	Roosevelt High School	San Antonio, TX	Bexar	Bexar	3/4/2008	Shell SP140PC	1.12	113.92	30	180
14	City Public Services Primary Control Center	San Antonio, TX	Bexar	Bexar	6/4/2008	BP MSX-120	17.28	1699.2	30*	N/A
15	Utopia ISD	Utopia, TX	Uvalde	Bexar	6/5/2008	GE Energy GEPV-050-M	1	121.4	30	180
16	Ft. Sam Houston Bldg. 1350	San Antonio, TX	Bexar	Bexar	4/6/2008	N/A	181	N/A	N/A	N/A
17	Kendall Elementary School	Boerne, TX	Kendall	Bexar	4/7/2008	Sharp Electronics NE-170-U2	1.02	84	35	180
18	Institute of Texan Cultures	San Antonio, TX	Bexar	Bexar	N/A	N/A	15	N/A	N/A	N/A
19	Bexar County Jail Annex	San Antonio, TX	Bexar	Bexar	N/A	N/A	N/A	N/A	N/A	N/A
20	El Campo Middle School	El Campo, TX	Wharton	Brazoria	7/1/1999	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
21	Alvin High School	Alvin, TX	Brazoria	Brazoria	11/3/2008	Shell SP-140-PC	1.12	113.92	30	180
22	Bluebonnet Elementary School	Lockhart, TX	Caldwell	Caldwell	7/5/2008	GE Energy GEPV-050-M	1	121.4	30	180
23	Leonard Shanklin Elementary School	Luling, TX	Caldwell	Caldwell	4/7/2008	Sharp Electronics NE-170-U4	1.02	84	35	180
24	Flatonia Elementary School	Flatonia, TX	Gonzales	Caldwell	5/7/2008	Sharp Electronics NE-170-U1	1.02	84	35	180
25	Waelder ISD	Waelder, TX	Gonzales	Caldwell	5/7/2008	Sharp Electronics NE-170-U5	1.02	64.08	35	180
26	Blue Ridge ISD	Blue Ridge, TX	Collin	Collin	10/3/2008	Siemens SP 75	0.9	81.84	25	180
27	McKinney Green Building	McKinney, TX	Collin	Collin	3/6/2008	ASE-300-DG-FT	45	3749.76	30*	N/A
28	Canyon High School	New Braunfels, TX	Comal	Comal	2/4/2008	Shell SP140PC	1.12	113.92	20	230
29	Dallas ISD Environmental Education Center	Seagoville, TX	Dallas	Dallas	2/4/2008	Shell Solar SP140PC	1.12	113.92	30	180
30	The Winston School	Dallas, TX	Dallas	Dallas	N/A	BP XXXXXXX	71	N/A	0	N/A

Table 6-2: Solar Photovoltaic Cell Projects: Data and Information (cont'd.).

Project No.	Solar Project	City/Town	County	County for ECALC	Date	PV Modules	Capacity(kW)	Total Area (sqft)	Slope	Azimuth (South=180)
31	Childress High School	Childress, TX	Childress	Denton	7/1/1999	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
32	Presidio High School	Presidio, TX	Presidio	El Paso	12/1/1999	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
33	Monahans High School	Monahans, TX	Ward	El Paso	12/1/2008	Siemens SP 75	0.9	81.84	60	180
34	Gene Roddenberry Planetarium	El Paso, TX	El Paso	El Paso	6/2/2008	4-kW ASE SunSine AC	3.42	313.44	25	180
35	Cordova Middle School	El Paso, TX	El Paso	El Paso	1/3/2008	Shell SP140PC	1.12	113.92	25	180
36	Weimar High School	Weimar, TX	Colorado	Fort Bend	5/5/2008	GE Energy GEPV-050-M	1	121.4	30	180
37	Univeresity of Texas Medical Branch at Galveston	Galveston, TX	Galveston	Galveston	3/2/2008	Solarex SX-80U	19.2	1892.88	30*	180*
38	Pine Tree Junior High School	Longview, TX	Gregg	Gregg	3/1/2000	ASE Americas ASE-300-DG/50	4.56	417.92	25	180
39	Marion Middle School	Marion, TX	Guadalupe	Guadalupe	5/5/2008	GE Energy GEPV-050-M	1	121.4	30	180
40	House in Brenham	Brenham, TX	Washington	Harris	12/1/1999	Solarex SJ-7500	1.2	N/A	N/A	N/A
41	UT Health Science Center	Houston, TX	Harris	Harris	2/1/2000	Solarex SJ-7500	1.5	271	30*	180*
42	Houston Ship Channel	Houston, TX	Harris	Harris	9/1/2000	BP SX65U	0.78	72	30*	N/A
43	Seabrook Intermediate School	Seabrook, TX	Harris	Harris	11/3/2008	Shell SP-140-PC	1.12	113.92	60	180
44	NASA Johnson Space Center	Houston, TX	Harris	Harris	10/4/2008	MSX-121	9.72	955.8	30*	180*
45	Brenham Jr. High School	Brenham, TX	Washington	Harris	02/01/07	Sharp NE-170-U1	1.02	10.68	35	180
46	Hempstead Middle School	Hempstead, TX	Washington	Harris	4/7/2008	Sharp Electronics NE-170-U1	1.02	84	35	180
47	Aircraft Obstruction Light	Houston, TX	Harris	Harris	N/A	SX65U	N/A	162.6	30*	180*
48	Learning Center at Sheldon Lake State Park	Houston, TX	Harris	Harris	N/A	BP Solar	170	108.4	40	180*
49	Learning Center at Sheldon Lake State Park	Houston, TX	Harris	Harris	N/A	N/A	N/A	81.3	25	180*
50	Upper Kirby District Center	Houston, TX	Harris	Harris	N/A	BP XXXXXXX	53	N/A	N/A	N/A
51	Jefferson Middle School	Jefferson, TX	Harrison	Harrison	9/1/1999	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
52	Abilene School District Planetarium	Abilene, TX	Taylor	Hood	8/1/1999	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
53	Brooksmith ISD	Brooksmith, TX	Brown	Hood	11/1/2008	Siemens SP 75	0.9	81.84	90	180
54	Brenham Middle School	Brenham, TX	Washington	Montgomery	6/5/2008	GE Energy GEPV-050-M	1	121.4	30	180
55	Solar Powered Water Pumping	Bryan, TX	Brazos	Montgomery	N/A	Solarex MST-43/mv	N/A	271	30*	180*
56	Martin High School	Laredo, TX	Webb	Nueces	10/1/1999	ASE Americas ASE-300-DG/50	4.56	418.08	0.01	180
57	Calallen High School	Corpus Cristi, TX	Nueces	Nueces	11/1/1999	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
58	Mission High School	Mission, TX	Hidalgo	Nueces	2/1/2000	ASE Americas ASE-300-DG/50	4.56	417.92	25	180
59	Rio Hondo High School	Rio Hondo, TX	Cameron	Nueces	4/1/2000	ASE Americas ASE-300-DG/50	4.56	417.92	25	180
60	Solar Powered Reverse Osmosis in Colorado Acres	Laredo, TX	Webb	Nueces	N/A	BP3150U	7.2	620.64	30*	180*

Table 6-2: Solar Photovoltaic Cell Projects: Data and Information (cont'd.).

Project No.	Solar Project	City/Town	County	County for ECALC	Date	PV Modules	Capacity(kW)	Total Area (sqft)	Slope	Azimuth (South=180)
61	Hamlin ISD	Hamlin, TX	Jones	Parker	11/1/2008	Siemens SP 75	0.9	81.84	25	180
62	Ira ISD	Ira, TX	Scurry	Parker	11/01/01	Siemens SP 75	0.9	6.82	60	180
63	Holliday ISD	Holliday, TX	Archer	Parker	12/1/2008	Siemens SP 75	0.9	81.84	60	180
64	River Road ISD	Amarillo, TX	Potter	Parker	12/1/2008	Siemens SP 75	0.9	81.84	60	180
65	Spring Hill Junior High School	Longview, TX	Smith	Smith	11/1/1999	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
66	Vliet Residence	Austin, TX	Travis	Travis	1/1/1999	Siemens SP 75	1.8	163.92	20	260
67	Sonora High School	Sonora, TX	Sutton	Travis	12/1/1999	ASE Americas ASE-300-DG/50	4.56	418.08	15	220
68	Maplewood Elementary School	Austin, TX	Travis	Travis	10/1/2008	Siemens SP 75	1.8	163.68	25	180
69	Bryker Woods Elementary School	Austin, TX	Travis	Travis	10/3/2008	Shell SP-150-PC	1.2	113.92	60	195
70	Kealing Middle School	Austin, TX	Travis	Travis	1/4/2008	Shell SP140PC	1.2	113.92	60	180
71	Junction High School	Junction, TX	Kimble	Travis	2/4/2008	Shell SP-140-PC	1.12	113.92	60	180
72	Bedichek Middle Shool	Austin, TX	Travis	Travis	10/6/2008	Sharp ND-L3EJEA	4.059	352.44	30	180
73	Blanton Elementary School	Austin, TX	Travis	Travis	10/6/2008	Sharp ND-L3EJEA	4.059	352.44	30	180
74	Cunningham elementary School	Austin, TX	Travis	Travis	10/6/2008	Sharp ND-L3EJEA	4.059	352.44	30	180
75	Garza High School	Austin, TX	Travis	Travis	10/6/2008	Sharp ND-L3EJEA	4.059	352.44	30	180
76	Martin Middle School	Austin, TX	Travis	Travis	10/6/2008	Sharp ND-L3EJEA	4.059	352.44	30	180
77	Murchison Middle School	Austin, TX	Travis	Travis	10/6/2008	Sharp ND-L3EJEA	4.059	352.44	30	180
78	O'Henry Middle School	Austin, TX	Travis	Travis	10/6/2008	Sharp ND-L3EJEA	4.059	352.44	30	180
79	Pond Springs Elementary School	Austin, TX	Travis	Travis	10/6/2008	Sharp ND-L3EJEA	4.059	352.44	30	180
80	Westwood High School	Austin, TX	Travis	Travis	10/6/2008	Sharp ND-L3EJEA	4.059	352.44	30	225
81	Zilker Elementary School	Austin TX	Travis	Travis	10/6/2008	Sharp ND-L3EJEA	4.059	352.44	30	180
82	Harper School	Harper, TX	Gillespie	Travis	3/7/2008	Sharp Electronics NE-170-U1	1.02	84	35	180
83	Llano Junior High School	Llano, TX	Llano	Travis	4/7/2008	Sharp Electronics NE-170-U5	1.02	84	35	180
84	San Marcos Electric Utility	San Marcos, TX	Travis	Travis	4/7/2008	Sharp Electronics NE-170-U5	1.02	64.08	35	180
85	Courtyard Tennis Club	Austin, TX	Travis	Travis	N/A	N/A	23	N/A	N/A	N/A
86	Escarpment Village	Austin, TX	Travis	Travis	N/A	N/A	7	N/A	N/A	N/A
87	IBM	Austin, TX	Travis	Travis	N/A	N/A	22	N/A	N/A	N/A
88	Hines Pool and Spa	Austin, TX	Travis	Travis	N/A	N/A	21	N/A	N/A	N/A
89	Centex Beverage Inc.	Austin, TX	Travis	Travis	N/A	N/A	22	N/A	N/A	N/A
90	Lake Austin Marina	Austin , TX	Travis	Travis	N/A	N/A	21	N/A	N/A	N/A

Table 6-2: Solar Photovoltaic Cell Projects: Data and Information (cont'd.).

Project No.	Solar Project	City/Town	County	County for ECALC	Date	PV Modules	Capacity(kW)	Total Area (sqft)	Slope	Azimuth (South=180)
91	Habitat Suites	Austin, TX	Travis	Travis	N/A	N/A	17	N/A	N/A	N/A
92	Palmer events Center	Austin, TX	Travis	Travis	N/A	N/A	36	N/A	N/A	N/A
93	LCRA Environmental Laboratory	Austin, TX	Travis	Travis	N/A	N/A	22	N/A	N/A	N/A
94	Austin Bergstrom International Airport	Austin, TX	Travis	Travis	N/A	N/A	32	N/A	N/A	N/A
95	Sand Hill power Plant, Control Building	Austin, TX	Travis	Travis	N/A	N/A	15	N/A	N/A	N/A
96	Spring Terrace	Austin, TX	Travis	Travis	N/A	N/A	18	N/A	N/A	N/A
97	American YouthWorks	Austin, TX	Travis	Travis	N/A	N/A	21	N/A	N/A	N/A
98	Town Lake Trail Foundation	Austin, TX	Travis	Travis	N/A	N/A	0.5	N/A	N/A	N/A
99	Garden Terrace	Austin, TX	Travis	Travis	N/A	N/A	21	N/A	N/A	N/A
100	Vintage Creek learning Center	Austin, TX	Travis	Travis	N/A	N/A	11	N/A	N/A	N/A
101	Ebeneezer Baptist Church	Austin, TX	Travis	Travis	N/A	N/A	8.4	N/A	N/A	N/A
102	Sierra Ridge	Austin, TX	Travis	Travis	N/A	N/A	17	N/A	N/A	N/A
103	Westcave Preserve	Round Mountain, TX	Llano	Travis	N/A	N/A	1.7	N/A	N/A	N/A
104	St. Andrews Episcopal School	Austin, TX	Travis	Travis	N/A	N/A	22	N/A	N/A	N/A
105	St. Gabriel Catholic Church	Austin, TX	Travis	Travis	N/A	N/A	21	N/A	N/A	N/A
106	Hornsby Bend Birding Shelter	Austin, TX	Travis	Travis	N/A	N/A	0.3	N/A	N/A	N/A
107	Casa Verde	Austin, TX	Travis	Travis	N/A	N/A	1.5	N/A	N/A	N/A
108	City Hall, Austin, Texas	Austin, TX	Travis	Travis	xxx-04	PROSOL (type-austin)***	9.74	894.3	30*	180*
109	Mineola High School	Mineola, TX	Wood	Upshur	10/1/1999	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
110	Cuero Junior High School	Cuero, TX	DeWitt	Victoria	6/5/2008	GE Energy GEPV-050-M	1	121.4	30	180
111	Solar Powered Water Purification	Matagorda Island, TX	Calhoun	Victoria	N/A	BP585U	N/A	111.23	30*	180*
112	Central High School	San Angelo, TX	Tom Green	Williamson	7/1/1999	ASE Americas ASE-300-DG/50	4.56	418.08	25	180
113	Davis Elementary School	Round Rock, TX	Williamson	Williamson	10/6/2008	Sharp ND-L3EJEA	4.059	352.44	30	180
114	Lampasas Middle School	Lampasas, TX	Lampasas	Williamson	4/7/2008	Sharp Electronics NE-170-U3	1.02	84	35	180

Note: (*) = Assumed

Table 6-3: Solar Photovoltaic Cell Projects: Energy and NOx Reductions.

Proj. No	Project	County For Ecalc	Annual Energy Savings (for base year conditions) and Emissions Reduction In lbs/year							Energy Savings (for base year conditions) and Average Emissions Reduction In lbs/day Per Ozone Season Day						
			Annual Energy Consumption (kWh/yr)	1999			2007			Annual Energy Consumption (kWh/yr)	1999			2007		
				NO_x	SO_x	CO_2	NO_x	SO_x	CO_2		NO_x	SO_x	CO_2	NO_x	SO_x	CO_2
1	La Grange Intermediate School	Bastrop	1774	6.9	3.92	2548	2.9	1.62	2286	5	0.02	0.01	8	0.01	0	7
2	Giddings Middle School	Bastrop	1774	6.9	3.92	2548	2.9	1.62	2286	5	0.02	0.01	8	0.01	0	7
3	Schulenburg Elementary School	Bastrop	1774	6.9	3.92	2548	2.9	1.62	2286	5	0.02	0.01	8	0.01	0	7
4	Smithville Junior High School	Bastrop	1774	6.9	3.92	2548	2.9	1.62	2286	5	0.02	0.01	8	0.01	0	7
5	Bastrop Intermediate School	Bastrop	1212	4.71	2.67	1741	1.98	1.11	1562	4	0.01	0.01	5	0.01	0	4
6	Del Rio High School	Bexar	6165	16.26	5.85	9155	10.17	10.1	10013	19	0.05	0.02	28	0.03	0.02	30
7	Uvalde Junior High School	Bexar	6165	16.26	5.85	9155	10.17	10.1	10013	19	0.05	0.02	28	0.03	0.02	30
8	John Jay High School	Bexar	1013	2.67	0.96	1505	1.67	1.66	1646	3	0.01	0	4	0	0	4
9	Eagle Pass High School - CC Winn Campus	Bexar	1207	3.18	1.15	1792	1.99	1.98	1960	4	0.01	0	6	0.01	0	6
10	James Madison High School	Bexar	1207	3.18	1.15	1792	1.99	1.98	1960	4	0.01	0	6	0.01	0	6
11	City Public Services of San Antonio, Northside	Bexar	24895	65.67	23.63	36970	41.08	40.79	40436	75	0.2	0.07	112	0.12	0.08	120
12	East Central ISD	Bexar	1411	3.72	1.34	2096	2.33	2.31	2292	4	0.01	0	6	0.01	0	6
13	Roosevelt High School	Bexar	1669	4.4	1.58	2478	2.75	2.73	2711	5	0.01	0	7	0.01	0.01	8
14	City Public Services Primary Control Center	Bexar	24895	65.67	23.63	36970	41.08	40.79	40436	75	0.2	0.07	112	0.12	0.08	120
15	Utopia ISD	Bexar	1779	4.69	1.69	2641	2.94	2.91	2889	5	0.01	0.01	8	0.01	0.01	9
16	Ft. Sam Houston Bldg. 1350	Bexar	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
17	Kendall Elementary School	Bexar	1215	3.21	1.15	1805	2.01	1.99	1974	4	0.01	0	5	0.01	0	6
18	Institute of Texan Cultures	Bexar	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
19	Bexar County Jail Annex	Bexar	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
20	El Campo Middle School	Brazoria	5513	13.31	11.41	8670	9.54	7.4	7790	17	0.04	0.03	26	0.03	0.02	23
21	Alvin High School	Brazoria	1490	3.6	3.08	2344	2.58	2	2106	4	0.01	0.01	7	0.01	0	6
22	Bluebonnet Elementary School	Caldwell	1774	4.93	1.02	2469	2.13	0.71	2087	5	0.01	0	7	0.01	0	6
23	Leonard Shanklin Elementary School	Caldwell	1212	3.36	0.7	1687	1.46	0.49	1426	4	0.01	0	5	0	0	4
24	Flatonia Elementary School	Caldwell	1212	3.36	0.7	1687	1.46	0.49	1426	4	0.01	0	5	0	0	4
25	Waelder ISD	Caldwell	925	2.57	0.53	1287	1.11	0.37	1088	3	0.01	0	4	0	0	3
26	Blue Ridge ISD	Collin	1230	4.72	2.73	1777	2	1.12	1586	4	0.01	0.01	6	0.01	0	5
27	McKinney Green Building	Collin	56096	215.35	124.75	81061	91.21	50.98	72330	171	0.66	0.38	248	0.28	0.07	213
28	Canyon High School	Comal	1681	4.43	1.6	2496	2.77	2.75	2730	5	0.01	0.01	8	0.01	0.01	8
29	Dallas ISD Environmental Education Center	Dallas	1704	6.62	3.76	2448	2.79	1.56	2196	5	0.02	0.01	7	0.01	0	6
30	The Winston School	Dallas	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 6-3: Solar Photovoltaic Cell Projects: Energy and NOx Reductions (cont'd.).

Proj. No	Project	County For Ecalc	Annual Energy Savings (for base year conditions) and Emissions Reduction In lbs/year							Energy Savings (for base year conditions) and Average Emissions Reduction In lbs/day Per Ozone Season Day						
			Annual Energy Consumption (kWh/yr)	1999			2007			Annual Energy Consumption (kWh/yr)	1999			2007		
				NO_x	SO_x	CO_2	NO_x	SO_x	CO_2		NO_x	SO_x	CO_2	NO_x	SO_x	CO_2
31	Childress High School	Denton	6284	24.12	13.98	9081	10.22	5.71	8103	20	0.08	0.04	28	0.03	0.01	24
32	Presidio High School	El Paso	7370	0	0	0	0	0	0	21	0	0	0	0	0	0
33	Monahans High School	El Paso	1240	0	0	0	0	0	0	3	0	0	0	0	0	0
34	Gene Roddenberry Planetarium	El Paso	5525	0	0	0	0	0	0	16	0	0	0	0	0	0
35	Cordova Middle School	El Paso	2008	0	0	0	0	0	0	6	0	0	0	0	0	0
36	Weimar High School	Fort Bend	1588	3.84	3.25	2490	2.77	2.16	2249	5	0.01	0.01	7	0.01	0.01	7
37	Univeresity of Texas Medical Branch at Galveston	Galveston	24763	59.8	51.24	38942	42.85	33.23	34990	74	0.18	0.15	116	0.12	0.08	101
38	Pine Tree Junior High School	Gregg	5747	0	0	0	0	0	0	18	0	0	0	0	0	0
39	Marion Middle School	Guadalupe	1779	4.69	1.69	2641	2.94	2.91	2889	5	0.01	0.01	8	0.01	0.01	9
40	House in Brenham	Harris	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
41	UT Health Science Center	Harris	3545	5.92	5.01	3835	4.26	3.33	3464	11	0.02	0.01	11	0.01	0.01	10
42	Houston Ship Channel	Harris	942	1.57	1.33	1019	1.13	0.89	920	3	0	0	3	0	0	3
43	Seabrook Intermediate School	Harris	1255	2.1	1.77	1358	1.51	1.18	1226	3	0.01	0	4	0	0	3
44	NASA Johnson Space Center	Harris	12504	20.87	17.66	13.53	15.04	11.75	12216	37	0.06	0.05	40	0.04	0.03	35
45	Brenham Jr. High School	Harris	826	1.38	1.17	893	0.99	0.78	807	2	0	0	3	0	0	2
46	Hempstead Middle School	Harris	1083	1.81	1.53	1171	1.3	1.02	1058	3	0.01	0	3	0	0	3
47	Aircraft Obstruction Light	Harris	2127	3.65	3	2301	2.56	2	2078	6	0.01	0.01	7	0.01	0	6
48	Learning Center at Sheldon Lake State Park	Harris	1372	2.29	1.94	1484	1.65	1.29	1340	4	0.01	0.01	4	0	0	4
49	Learning Center at Sheldon Lake State Park	Harris	1072	1.79	1.51	1160	1.29	1.01	1048	3	0.01	0	4	0	0	3
50	Upper Kirby District Center	Harris	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
51	Jefferson Middle School	Harrison	5749	0	0	0	0	0	0	18	0	0	0	0	0	0
52	Abilene School District Planetarium	Hood	6284	24.12	19.98	9081	10.22	5.71	8103	20	0.08	0.04	28	0.03	0.01	24
53	Brooksmith ISD	Hood	670	2.57	1.49	969	1.09	0.61	864	1	0.01	0	2	0	0	2
54	Brenham Middle School	Montgomery	1588	2.65	2.24	1718	1.91	1.49	1552	5	0.01	0.01	5	0.01	0	4
55	Solar Powered Water Pumping	Montgomery	3545	5.92	5.01	3835	4.26	3.33	3464	11	0.02	0.01	11	0.01	0.01	10
56	Martin High School	Nueces	5373	14.91	3.09	7478	6.45	2.15	6320	18	0.05	0.01	25	0.02	0	20
57	Calallen High School	Nueces	5567	15.45	3.2	7748	6.68	2.23	6549	17	0.05	0.01	24	0.02	0	20
58	Mission High School	Nueces	5565	15.45	3.2	7746	6.68	2.23	6546	17	0.05	0.01	24	0.02	0	20
59	Rio Hondo High School	Nueces	5565	15.45	3.2	7746	6.68	2.23	6546	17	0.05	0.01	24	0.02	0	20
60	Acres	Nueces	8187	22.73	4.7	11395	9.83	3.28	9630	25	0.07	0.01	35	0.03	0.01	28

Table 6-3: Solar Photovoltaic Cell Projects: Energy and NOx Reductions (cont'd.).

Proj. No	Project	County For Ecalc	Annual Energy Savings (for base year conditions) and Emissions Reduction In lbs/year							Energy Savings (for base year conditions) and Average Emissions Reduction In lbs/day Per Ozone Season Day						
			Annual Energy Consumption (kWh/yr)	1999			2007			Annual Energy Consumption (kWh/yr)	1999			2007		
				NO_x	SO_x	CO_2	NO_x	SO_x	CO_2		NO_x	SO_x	CO_2	NO_x	SO_x	CO_2
61	Hamlin ISD	Parker	1230	4.78	2.71	1766	2.01	1.13	1585	4	0.01	0.01	6	0.01	0	5
62	Ira ISD	Parker	1047	4.07	2.31	1504	1.71	0.96	1349	3	0.01	0.01	4	0	0	3
63	Holliday ISD	Parker	1047	4.07	2.31	1504	1.71	0.96	1349	3	0.01	0.01	4	0	0	3
64	River Road ISD	Parker	1047	4.07	2.31	1504	1.71	0.96	1349	3	0.01	0.01	4	0	0	3
65	Spring Hill Junior High School	Smith	5749	22.35	12.69	8258	9.4	5.26	7408	18	0.07	0.04	26	0.03	0.01	22
66	Vliet Residence	Travis	2415	9.27	5.22	3465	3.92	2.17	3109	8	0.03	0.02	11	0.01	0	9
67	Sonora High School	Travis	6131	23.54	13.25	8795	9.96	5.51	7891	20	0.07	0.04	28	0.03	0.01	24
68	Maplewood Elementary School	Travis	2408	9.25	5.2	3455	3.91	2.17	3100	7	0.03	0.02	11	0.01	0	9
69	Bryker Woods Elementary School	Travis	1404	5.39	3.03	2014	2.28	1.26	1807	4	0.01	0.01	5	0.01	0	5
70	Kealing Middle School	Travis	1404	5.39	3.03	2014	2.28	1.26	1807	4	0.01	0.01	5	0.01	0	5
71	Junction High School	Travis	1404	5.39	3.03	2014	2.28	1.26	1807	4	0.01	0.01	5	0.01	0	5
72	Bedichek Middle Shool	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
73	Blanton Elementary School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
74	Cunningham elementary School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
75	Garza High School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
76	Martin Middle School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
77	Murchison Middle School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
78	O'Henry Middle School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
79	Pond Springs Elementary School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
80	Westwood High School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
81	Zilker Elementary School	Travis	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
82	Harper School	Travis	1212	4.65	2.62	1739	1.97	1.09	1560	4	0.01	0.01	5	0.01	0	4
83	Llano Junior High School	Travis	1212	4.65	2.62	1739	1.97	1.09	1560	4	0.01	0.01	5	0.01	0	4
84	San Marcos Electric Utility	Travis	925	3.55	2	1326	1.5	0.83	1190	3	0.01	0.01	4	0	0	3
85	Courtyard Tennis Club	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
86	Escarpment Village	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
87	IBM	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
88	Hines Pool and Spa	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
89	Centex Beverage Inc.	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
90	Lake Austin Marina	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Table 6-3: Solar Photovoltaic Cell Projects: Energy and NOx Reductions (cont'd.).

Proj. No	Project	County For Ecalc	Annual Energy Savings (for base year conditions) and Emissions Reduction In lbs/year							Energy Savings (for base year conditions) and Average Emissions Reduction In lbs/day Per Ozone Season Day						
			Annual Energy Consumption (kWh/yr)	1999			2007			Annual Energy Consumption (kWh/yr)	1999			2007		
				NO_x	SO_x	CO_2	NO_x	SO_x	CO_2		NO_x	SO_x	CO_2	NO_x	SO_x	CO_2
91	Habitat Suites	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
92	Palmer events Center	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
93	LCRA Environmental Laboratory	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
94	Austin Bergstrom International Airport	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
95	Sand Hill power Plant, Control Building	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
96	Spring Terrace	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
97	American YouthWorks	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
98	Town Lake Trail Foundation	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
99	Garden Terrace	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
100	Vintage Creek learning Center	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
101	Ebeneezer Baptist Church	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
102	Sierra Ridge	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
103	Westcave Preserve	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
104	St. Andrews Episcopal School	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
105	St. Gabriel Catholic Church	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
106	Hornsby Bend Birding Shelter	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
107	Casa Verde	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
108	City Hall, Austin, Texas	Travis	13069	50.19	28.24	18747	21.23	11.75	16821	39	0.15	0.09	57	0.06	0.02	49
109	Mineola High School	Upshur	5749	0	0	0	0	0	0	18	0	0	0	0	0	0
110	Cuero Junior High School	Victoria	1624	4.51	0.93	2260	1.95	0.65	1910	5	0.01	0	7	0.01	0	6
111	Solar Powered Water Purification	Victoria	1488	4.13	0.86	2071	1.79	0.6	1750	4	0.01	0	6	0.01	0	5
112	Central High School	Williamson	6151	23.62	13.29	8824	9.99	5.53	7917	19	0.07	0.04	27	0.03	0.01	23
113	Davis Elementary School	Williamson	5150	19.78	11.13	7389	8.37	4.63	6629	16	0.06	0.03	22	0.03	0.01	19
114	Lampasas Middle School	Williamson	1212	4.65	2.62	1739	1.97	1.09	1560	4	0.01	0.01	5	0.01	0	4
	TOTAL		**362212**	**9074.6**	**594.79**	**465534.5**	**8558.29**	**360.65**	**449179**	**1101**	**7999.23**	**1.72**	**1446**	**8029.64**	**0.62**	**1310**

Table 6-4: Solar Thermal Projects.

Project No.	City	County	County for eCalc	Project Purpose	Model	Collector Area (sqft)	Number of collectors	Total Area (sqft)	Slope (degree)	Azimuth (i.e. South=0, West (-) and East (+))	Fluid
1	Austin	Travis	Travis	Domestic Hot Water (DHW)	N/A	N/A	2	N/A	N/A	0	Antifreeze
2	Austin	Travis	Travis	Domestic Hot Water (DHW)	SS HX Drainback	26.25	3	78.75	20	0	Water
3	Round Rock	Willamson	Willamson	Domestic Hot Water (DHW)	SS HX Drainback	26.25	2	52.5	20	-90	Water
4	Dripping Springs	Hays	Hays	Domestic Hot Water (DHW)	SS HX Drainback	26.25	2	52.5	20	20	Water
5	San Antonio	Bexar	Bexar	Domestic Hot Water (DHW)	SS HX Drainback	26.25	2	52.5	20	0	Water
6	San Antonio	Bexar	Bexar	Pool Heating System	FS collector	32	8	256	20	-45	Water
7	N/A	N/A	N/A	Domestic Hot Water (DHW)	SS HX Drainback	26.25	3	78.75	20	-45	Water
8	N/A	N/A	N/A	Domestic Hot Water (DHW)	SS HX Drainback	26.25	2	52.5	20	-45	Water
9	Midland	Midland	N/A	Pool Heating System-city of midland aquatic center	HC 50 collectors-make:APS	50	256	12800	N/A	N/A	Water
10	Lubbock	Lubbock	N/A	Pool Heating System-Lubbock TX State School	HC 50 collectors-make:APS	50	36	1800	N/A	N/A	Water
11	Corpus Christi	Nueces	N/A	Pool Heating System-Corpus Christi TX State School	HC 50 collectors-make:APS	50	36	1800	N/A	N/A	Water
12	Richmond	Fort Bend	N/A	Pool Heating System-Richmond TX State School	HC 50 collectors-make:APS	50	36	1800	N/A	N/A	Water
13	Elpaso	Elpaso	N/A	Pool Heating System-University of Elpaso recreation facility	HC 50 collectors-make:APS	50	120	6000	N/A	N/A	Water
14	Elpaso	Elpaso	N/A	Pool Heating System-University of Elpaso recreation facility	HC 50 collectors-make:APS	50	128	6400	N/A	N/A	Water

Table 6-5: Solar Thermal Projects Emissions Reductions.

Project	County for ECALC	Annual Energy Savings (for base year conditions) and Emissions Reduction In lbs/year							Energy Savings (for base year conditions) and Average Emissions Reduction In lbs/day Per Ozone Season Day						
		Annual Energy Consumption (kWh/yr)	1999			2007			Annual Energy Consumption (kWh/yr)	1999			2007		
			NO_x	SO_x	CO_2	NO_x	SO_x	CO_2		NO_x	SO_x	CO_2	NO_x	SO_x	CO_2
1	Travis	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
2	Travis	4134	15.87	8.93	5930	6.71	3.72	5320	14	0.05	0.03	20	0.02	0.01	17
3	Willamson	3211	12.33	6.94	4606	5.22	2.89	4133	13	0.05	0.03	18	0.02	0	16
4	Hays	3469	9.16	2.44	4791	4.41	1.14	4234	12	0.03	0.01	17	0.02	0	15
5	Bexar	3469	9.15	3.29	5152	5.73	5.68	5635	12	0.03	0.01	18	0.02	0.01	19
6	Bexar	26235	69.2	24.9	38960	43.3	42.98	42.612	87	0.23	0.08	130	0.14	0.09	140
7	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
9	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
10	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
12	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
13	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
14	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
TOTAL		**40518**	**115.71**	**46.5**	**59439**	**65.37**	**56.41**	**19364.612**	**138**	**0.39**	**0.16**	**203**	**0.22**	**0.11**	**207**

Table 6-6: Solar Thermal Special Project.

Special Case	
Location	Fort Sam Houston, San Antonio TX
Date	3-Jun
Collector	Roof Mounted Parabolic Trough
Number of collectors	129
Total Aperture area (sqft)	4515
Maximum operation temperature (°F)	400
Annual Energy Consumption (KWh/yr)	270583
Annual Energy Consumption OSD (KWh/yr) (KWh/yr)	741.3

Table 6-7: Hydropower Plant Information.

No.	Utility Name	Plant Name	County	Initial Year Of Operation	Capacity in MW	STATUS
1	Guadalupe Blanco River Auth	Abbott TP 3	Victoria	1927	1.4	operational
2	Guadalupe Blanco River Auth	Abbott TP 3	Victoria	1927	1.4	operational
3	Guadalupe Blanco River Auth	Dunlap TP 1	Guadalupe	1927	1.8	operational
4	Guadalupe Blanco River Auth	Dunlap TP 1	Guadalupe	1927	1.8	operational
5	Guadalupe Blanco River Auth	Nolte	Williamson	1927	1.2	operational
6	Guadalupe Blanco River Auth	Nolte	Williamson	1927	1.2	operational
7	Guadalupe Blanco River Auth	H 4	Guadalupe	1931	2.4	operational
8	Guadalupe Blanco River Auth	H 5	Guadalupe	1931	2.4	operational
9	Guadalupe Blanco River Auth	TP 4	Guadalupe	1932	2.4	operational
10	Maverick Cty Water Control & Improvement	Eagle Pass	Maverick	1932	3.2	operational
11	Maverick Cty Water Control & Improvement	Eagle Pass	Maverick	1932	3.2	operational
12	Maverick Cty Water Control & Improvement	Eagle Pass	Maverick	1932	3.2	operational
13	Lower Colorado River Authority	Buchanan	Burnet	1938	18.3	operational
14	Lower Colorado River Authority	Buchanan	Burnet	1938	18.3	operational
15	Lower Colorado River Authority	Buchanan	Burnet	1938	11.2	operational
16	Lower Colorado River Authority	Inks	Burnet	1938	15	operational
17	Lower Colorado River Authority	Austin	Lampasas	1941	8	operational
18	Lower Colorado River Authority	Austin	Lampasas	1941	8	operational
19	Lower Colorado River Authority	Marshall Ford	Travis	1941	34	operational
20	Lower Colorado River Authority	Marshall Ford	Travis	1941	34.5	operational
21	Lower Colorado River Authority	Marshall Ford	Travis	1941	34	operational
22	Brazos River Authority	Morris Sheppard	Palo Pinto	1942	12.5	operational
23	Brazos River Authority	Morris Sheppard	Palo Pinto	1942	12.5	operational
24	USCE-Tulsa District	Denison	Grayson	1945	35	operational
25	USCE-Tulsa District	Denison	Grayson	1949	35	operational
26	Lower Colorado River Authority	Granite Shoals	Burnet	1951	30	operational
27	Lower Colorado River Authority	Granite Shoals	Burnet	1951	30	operational
28	Lower Colorado River Authority	Marble Falls	Burnet	1951	15	operational
29	Lower Colorado River Authority	Marble Falls	Burnet	1951	15	operational
30	USCE-Fort Worth District	Whitney	Bosque	1953	15	operational
31	USCE-Fort Worth District	Whitney	Bosque	1953	15	operational
32	International Bound & Wtr Comm	Falcon Dam & Power	Zapata	1954	10.5	operational
33	International Bound & Wtr Comm	Falcon Dam & Power	Zapata	1954	10.5	operational
34	International Bound & Wtr Comm	Falcon Dam & Power	Zapata	1954	10.5	operational
35	USCE-Fort Worth District	Sam Rayburn	Jasper	1965	26	operational
36	USCE-Fort Worth District	Sam Rayburn	Jasper	1965	26	operational
37	Entergy Gulf States Inc	Toledo Bend	Newton	1969	40.5	operational
38	Entergy Gulf States Inc	Toledo Bend	Newton	1969	40.5	operational
39	International Bound & Wtr Comm	Amistad Dam & Power	Valverde	1983	33	operational
40	International Bound & Wtr Comm	Amistad Dam & Power	Valverde	1983	33	Operational
41	Guadalupe Blanco River Auth	Canyon	Randall	1989	3	Operational
42	Guadalupe Blanco River Auth	Canyon	Randall	1989	3	Operational
43	USCE-Fort Worth District	Robert D Willis	Harris	1989	4	Operational
44	USCE-Fort Worth District	Robert D Willis	Harris	1989	4	Operational
45	City of Garland	Lewisville	Denton	1992	2.8	Operational
				Total	669.2	

Table 6-8: Geothermal Heat Pump Energy Projects.

No	Project	County	Implementation Date	Capacity (ton)	Area (sqft)
1	Birdville High School Campus	Denton	2001	N/A	N/A
2	Texas Motor Speedway	Denton	1998	N/A	N/A
3	George W. Bush's ranch	McLennan	2001	14	N/A
4	Esperanza del Sol, Dallas (Hope of the Sun)	Dallas	1994	18	15276
5	Hillside Oaks, East Dallas	Dallas	1997	366	276120
6	Pease Elementary School, Austin	Travis	1997	90	39162
7	Brooke Elementary School	Travis	1997	150	51605
8	Govalle Elementary School	Travis	1997	230	89319
9	Bailey Middle School, Austin	Travis	1997	512	200000
10	Home in Iowa Park	Wichita	1997	1	1668
11	The Home of the Future	Dallas	1997	13	4573
12	Birdville Athletic Complex / Stadium	Tarrant	post 1992	N/A	60,000 Sq Ft
13	Frisco ISD Administration Building and Network Operations Center	Collin	post 1992	N/A	20,000+ Sq Ft
14	Aubrey Athletic Complex / Stadium	Denton	post 1992	N/A	N/A
15	Lake Dallas Athletic Complex / Stadium	Denton	post 1992	N/A	N/A
16	Wakeland High School	Collin	post 1992	N/A	300,000+ Sq Ft
17	Lovejoy High School	Collin	post 1992	N/A	200,000+ Sq Ft
18	Grand Prairie High Ninth Grade Center	Dallas	post 1992	N/A	150,000+ Sq Ft
19	South Grand Prairie High Ninth Grade Center	Dallas	post 1992	N/A	100,000+ Sq Ft
20	David Daniels Elementary	Dallas	post 1992	N/A	70,000+ Sq Ft
21	Edelweiss Daniels Elementary	Dallas	post 1992	N/A	70,000+ Sq Ft
22	Crockett Elementary	Dallas	post 1992	N/A	70,000+ Sq Ft
23	Kirby Elementary	Dallas	post 1992	N/A	70,000+ Sq Ft
24	Renovations to HVAC System at South Grand Prairie High School	Dallas	post 1992	N/A	300,000 Sq Ft
25	Renovations to HVAC System at Jackson Middle School	Dallas	post 1992	N/A	N/A
26	Renovations to HVAC System at Lee Middle School	Dallas	post 1992	N/A	81,000+ Sq Ft
27	Rebuild of Lee Middle School (Fire Damage)	Dallas	post 1992	N/A	10,000+ Sq Ft
28	Renovations/Additions to Adams Middle School	Dallas	post 1992	N/A	N/A
29	Renovations/Additions to North Oaks Middle School	Tarrant	post 1992	N/A	71,000+ Sq Ft
30	Renovations/Additions to North Richland Middle School	Tarrant	post 1992	273	80,000+ Sq Ft
31	Renovations/Additions to Watauga Middle School	Tarrant	post 1992	N/A	80,000+ Sq Ft
32	Renovations to HVAC System at Jackson Middle School	Dallas	post 1992	N/A	N/A
33	Renovations to HVAC System at Eisenhower Elementary	Dallas	post 1992	N/A	N/A
34	Renovations/Additions to Rayburn Elementary	Dallas	post 1992	N/A	38,000+ Sq Ft
35	Renovations/Additions to Snow Heights Elementary School	Tarrant	post 1992	N/A	43,000+ Sq Ft
36	Renovations/Additions to Watauga Elementary School	Tarrant	post 1992	N/A	56,000+ Sq Ft
37	Renovations/Additions to Smithfield Elementary School	Tarrant	post 1992	N/A	56,000+ Sq Ft
38	Renovations to David E. Smith Elementary School	Tarrant	post 1992	N/A	45,000+ Sq Ft
39	Renovations/Additions to Green Valley Elementary School	Tarrant	post 1992	N/A	50,000+ Sq Ft
40	Renovations/Additions to Richland Elementary School	Tarrant	post 1992	221	38,000+ Sq Ft
41	Renovations/Additions to Birdville Elementary School	Tarrant	post 1992	N/A	32,000+ Sq Ft
42	Renovations/Additions to Grace Hardeman Elementary	Tarrant	post 1992	N/A	N/A
43	Renovations/Additions to W.A. Porter Elementary School	Tarrant	post 1992	N/A	48,000+ Sq Ft
44	Bells Elementary School	Grayson	post 1992	N/A	60,000+ sqft
45	HVAC Renovation for Haltom Middle School	Tarrant	post 1992	N/A	109,000 Sq Ft
46	HVAC Renovation for Richland Middle School`	Tarrant	post 1992	N/A	91,000 Sq Ft
47	HVAC Renovation for North Oaks Middle School	Tarrant	post 1992	N/A	70,000 Sq Ft
48	HVAC Renovation for North Richland Middle School	Tarrant	post 1992	N/A	75,000 Sq Ft
49	HVAC Renovation for Watauga Middle School	Tarrant	post 1992	N/A	90,000 Sq Ft
50	HVAC Renovation for Holiday Heights Elementary	Tarrant	post 1992	N/A	40,000 Sq Ft
51	HVAC Renovation for Watuaga Elementary	Tarrant	post 1992	N/A	40,000 Sq Ft
52	HVAC Renovation for David E. Smith Elementary	Tarrant	post 1992	N/A	35,000 Sq Ft
53	HVAC Renovation for West Birdville Elementary	Tarrant	post 1992	N/A	42,000 Sq Ft
54	HVAC Renovation for Glenview Elementary	Tarrant	post 1992	N/A	40,000 Sq Ft
55	HVAC Renovation for South Birdville Elementary	Tarrant	post 1992	149	38,000 Sq Ft

Table 6-8: Geothermal Heat Pump Energy Projects (cont'd.).

No	Project	County	Implementation Date	Capacity (ton)	Area (sqft)
56	HVAC Renovation for WT Francisco Elementary	Tarrant	post 1992	N/A	31,000 Sq Ft
57	HVAC Renovation for Foster Village Elementary	Tarrant	post 1992	N/A	66,000 Sq Ft
58	HVAC Renovation for Snow Heights Elementary	Tarrant	post 1992	124	33,000 Sq Ft
59	HVAC Renovation for OH Stowe Elementary	Tarrant	post 1992	N/A	40,000 Sq Ft
60	Jackson Middle School Replacement	Dallas	post 1992	N/A	100,000+ Sq Ft
61	Renovations/Additions to Green Valley Elementary School	Tarrant	post 1992	N/A	50,000+ Sq Ft
62	Renovations/Additions to Richland Elementary School	Tarrant	post 1992	N/A	38,000+
63	Renovations/Additions to Birdville Elementary School	Tarrant	post 1992	N/A	32,000+
64	Renovations/Additions to Grace Hardeman Elementary	Tarrant	post 1992	N/A	N/A
65	Renovations/Additions to W.A. Porter Elementary School	Tarrant	post 1992	N/A	48,000+
66	HVAC Renovation for Rayburn Elementary School	Dallas	post 1992	N/A	N/A
67	HVAC Renovation for Haltom Middle School	Tarrant	post 1992	N/A	109,000 Sq Ft
68	HVAC Renovation for North Oaks Middle School	Tarrant	post 1992	204	70,000 Sq Ft
69	HVAC Renovation for Watauga Middle School	Tarrant	post 1992	N/A	90,000 Sq Ft
70	HVAC Renovation for Holiday Heights Elementary	Tarrant	post 1992	N/A	40,000 Sq Ft
71	HVAC Renovation for Watuaga Elementary	Tarrant	post 1992	N/A	40,000 Sq Ft
72	HVAC Renovation for David E. Smith Elementary	Tarrant	post 1992	N/A	35,000 Sq Ft
73	HVAC Renovation for West Birdville Elementary	Tarrant	post 1992	106	42,000 Sq Ft
74	HVAC Renovation for Glenview Elementary	Tarrant	post 1992	N/A	40,000 Sq Ft
75	HVAC Renovation for South Birdville Elementary	Tarrant	post 1992	N/A	38,000 Sq Ft
76	HVAC Renovation for WT Francisco Elementary	Tarrant	post 1992	N/A	31,000 Sq Ft
77	HVAC Renovation for Foster Village Elementary	Tarrant	post 1992	N/A	66,000 Sq Ft
78	HVAC Renovation for Snow Heights Elementary	Tarrant	post 1992	N/A	33,000 Sq Ft
79	Corinth Elementary	Denton	post 1992	N/A	100,000+ Sq Ft
80	Anchor Church	Tarrant	post 1992	N/A	40,000+ Sq Ft
81	Little Elm Elementary	Denton	post 1992	N/A	70,000+ Sq Ft
82	Griffen Parc Middle School	Collin	post 1992	N/A	120,000+ Sq Ft
83	Riddle Elementary	Collin	post 1992	N/A	70,000+ Sq Ft
84	Boals Elementary	Collin	post 1992	N/A	70,000+ Sq Ft
85	Renovations to HVAC System at Grand Prairie High School	Dallas	post 1992	N/A	25,000+ Sq Ft
86	Lake Dallas Middle School	Denton	post 1992	N/A	250,000+ Sq Ft
87	North Elementary	Tarrant	post 1992	N/A	110,000+ Sq Ft
88	Isbell Elementary	Collin	post 1992	N/A	70,000+ Sq Ft
89	Bledsoe Elementary	Collin	post 1992	N/A	70,000+ Sq Ft
90	Roach Middle School	Collin	post 1992	N/A	120,000+ Sq Ft
91	Fowler Middle School	Collin	post 1992	N/A	120,000+ Sq Ft
92	North Star Elementary	Tarrant	post 1992	N/A	70,000+ Sq Ft
93	Hometown Elementary School	Tarrant	post 1992	N/A	70,000+ Sq Ft
94	Liberty High School	Collin	post 1992	N/A	300,000+ Sq Ft
95	Ashley Elementary	Collin	post 1992	N/A	70,000+ Sq Ft
96	Ogle Elementary	Collin	post 1992	N/A	70,000+ Sq Ft
97	Sem Elementary	Collin	post 1992	N/A	70,000+ Sq Ft
98	Corbell Elementary	Collin	post 1992	N/A	70,000+ Sq Ft
99	Taylor Elementary	Collin	post 1992	N/A	70,000+ Sq Ft
100	Middle School #5	Tarrant	post 1992	N/A	1,40,000+ Sq Ft
101	Intermediate School #5	Tarrant	post 1992	N/A	1,20,000+ Sq Ft
102	Liberty Elementary	Tarrant	post 1992	N/A	70,000+ Sq Ft
103	Stafford Middle School	Collin	post 1992	N/A	1,20,000+ Sq Ft
104	Scoggins Middle School	Collin	post 1992	N/A	1,20,000+ Sq Ft
105	Elementary #10	Tarrant	post 1992	N/A	70,000+ Sq Ft
106	Elementary #11	Tarrant	post 1992	N/A	70,000+ Sq Ft
107	Elementary #12	Tarrant	post 1992	N/A	70,000+ Sq Ft
108	Elementary #13	Tarrant	post 1992	N/A	70,000+ Sq Ft
109	Middle School #4	Tarrant	post 1992	N/A	1,20,000+ Sq Ft
110	Robertson Elementary	Collin	post 1992	N/A	70,000+ Sq Ft

Table 6-8: Geothermal Heat Pump Energy Projects (cont'd.).

No	Project	County	Implementation Date	Capacity (ton)	Area (sqft)
111	Mooneyham Elementary	Collin	post 1992	N/A	70,000+ Sq Ft
112	Carrol Elementary	Collin	post 1992	N/A	70,000+ Sq Ft
113	Brookstone Elementary	Collin	post 1992	N/A	70,000+ Sq Ft
114	Tadlock Elementary	Collin	post 1992	N/A	70,000+ Sq Ft
115	Aubrey Intermediate/Middle School	Denton	post 1992	N/A	80,000+ Sq Ft
116	Florence Hill Elementary	Dallas	post 1992	N/A	70,000+ Sq Ft
117	Garner Elementary	Dallas	post 1992	N/A	70,000+ Sq Ft
118	Bowie Elementary	Dallas	post 1992	N/A	25,000+ Sq Ft
119	High School #5	Collin	post 1992	N/A	300,000+ Sq Ft
120	High School #6	Collin	post 1992	N/A	300,000+ Sq Ft
121	Memorial Stadium Field House	Collin	post 1992	N/A	10,000+ Sq Ft
122	Rogers Elementary	Collin	post 1992	N/A	63,000+ Sq Ft
123	Camp Wisdom Elementary	Dallas	post 1992	N/A	70,000+ Sq Ft
124	Additions to Anderson Elementary	Collin	post 1992	N/A	9,000+ Sq Ft
125	Additions to Borchardt Elementary	Collin	post 1992	N/A	9,000+ Sq Ft
126	Additions to Bright Elementary	Collin	post 1992	N/A	9,000+ Sq Ft
127	Additions to Christi Elementary	Collin	post 1992	N/A	9,000+ Sq Ft
128	Additions to Curtsinger Elementary	Collin	post 1992	N/A	9,000+ Sq Ft
129	Additions to Fisher Elementary	Collin	post 1992	N/A	9,000+ Sq Ft
130	Additions to Shawnee Trail Elementary	Collin	post 1992	N/A	9000 + sqft
131	CATE Center (Career and Technology)	Collin	post 1992	N/A	100, 000+ sqft
132	CTE at Centennial High School (Career and Technology)	Collin	post 1992	N/A	9000+ sqft
133	Staley Middle School Field House	Collin	post 1992	N/A	6000+ sqft
134	West Transportation Facility	Collin	post 1992	N/A	25000+ sqft
135	McKinney Lofts	Dallas	N/A	N/A	N/A
136	Havana Club Apartments	Bexar	N/A	N/A	N/A
137	Hogg Palace Lofts	Harris	N/A	N/A	N/A
138	South Main Baptist Church	Harris	N/A	N/A	N/A
139	The Tower	Tarrant	N/A	N/A	N/A
140	Edgemere	Dallas	N/A	N/A	N/A
141	Radisson Carlson Park	Bexar	N/A	N/A	N/A
142	Biggs Field Project	El Paso	N/A	N/A	N/A
143	Denison Housing Authority	Grayson	N/A	N/A	N/A
144	Fort Sam Houston Barracks	Bexar	N/A	N/A	N/A
145	Fort Sam Houston Building 905/906	Bexar	N/A	N/A	N/A
146	Fort Walters	Palo pinto	N/A	N/A	N/A
147	Drury Inn & Suites	Bexar	N/A	N/A	N/A
148	Lexington Hotel Suites	Tarrant	N/A	N/A	N/A
149	Arnold Middle School	Dallas	N/A	N/A	N/A
150	Shaner Hotel	Bexar	N/A	N/A	N/A
151	Holiday Inn Northwest	Bexar	N/A	N/A	N/A
152	2ND Home Suites	Dallas	N/A	N/A	N/A
153	Homewood Suites	Bexar	N/A	N/A	N/A
154	Air Dynamics	Dallas	N/A	N/A	N/A
155	Radiatas	Webb	N/A	N/A	N/A
156	Hensley Field Operations Center	Dallas	N/A	N/A	N/A
157	Southwest Plaza Base Bldg	Dallas	N/A	N/A	N/A
158	Air Performance	Dallas	N/A	N/A	N/A
159	Meadwest VA Co.	Harris	N/A	N/A	N/A
160	Gap #1550 Mockingbird Station	Dallas	N/A	N/A	N/A
161	Kirby Building	Dallas	N/A	N/A	N/A
162	USSA Towers	Bexar	N/A	N/A	N/A
163	Trinity Towers	Nueces	N/A	N/A	N/A
164	Sonny Bryans BBQ	Dallas	N/A	N/A	N/A
165	L'Etoile Restaurant	Bexar	N/A	N/A	N/A

Table 6-8: Geothermal Heat Pump Energy Projects (cont'd.).

No	Project	County	Implementation Date	Capacity (ton)	Area (sqft)
166	Sweeny Ind.Sch. Dist.Warehouse	Brazoria	N/A	N/A	N/A
167	Freylands Elementary	Chambers	N/A	N/A	N/A
168	Mustang Mech. Montwood High	El Paso	N/A	N/A	N/A
169	Boerne Elementary School	Kendall	N/A	N/A	N/A
170	City View Schools	Wichita	N/A	N/A	N/A
171	Holiday Height Elementary School	Tarrant	N/A	N/A	N/A
172	Watauga Elementary School	Tarrant	N/A	N/A	N/A
173	Montwood High School Addition	El Paso	N/A	N/A	N/A
174	Montwood High School Auditorium	El Paso	N/A	N/A	N/A
175	The Island on Lake Travis	Travis	N/A	N/A	N/A
176	Allen Campus	Brazos	N/A	N/A	N/A
177	Judson Lofts	Bexar	N/A	N/A	N/A
178	pink elemtary school	collin	2004	N/A	N/A
179	Griffin middle school	collin	2002	N/A	N/A
180	Joslin Elementary	Travis	1991	N/A	N/A
181	Brent wood Elementary	Travis	1991	N/A	N/A
182	Walnut Creek Elementary	Travis	1991	N/A	N/A
183	Sims Elementary	Travis	1991	N/A	N/A
184	F R Rice Elementary	Travis	1991	N/A	N/A
185	T A Brown Elementary	Travis	1991	N/A	N/A
186	Canyon Ridge Middle School	William son	2004	N/A	N/A
187	Vista Ridge High School	William son	2004	N/A	N/A
188	Pleasant Hill Elemtary	William son	2005	N/A	N/A
189	Good Night Middle school	Hays	1985	N/A	N/A
190	Santa Teresa Elementary	Hays	N/A	125	N/A
191	Santa Teresa Middle School	Hays	N/A	200	N/A
192	Esconreras primary kindergarten	Hays	N/A	105	N/A
193	Mullendore Elementary	Tarrant	post 1995	N/A	N/A
194	O.H. Stowe Elementary	Tarrant	post 1995	N/A	N/A
195	Austin Elementary School GPISD	Dallas	post 1995	N/A	N/A
196	Fannin Elementary School GPISD	Dallas	post 1995	N/A	N/A
197	Peaster Elementary	Parker	post 1995	N/A	N/A
198	Frisco Elementary School #15	collin	post 1995	N/A	N/A
199	Lone Star Elementary - Frisco ISD	collin	post 1995	N/A	N/A
200	Woodland Springs Elementary - Keller ISD	Tarrant	post 1995	N/A	N/A
201	Bette Perot Elementary - Keller ISD	Tarrant	post 1995	N/A	N/A
202	Granbury Middle School East Site	Hood	post 1995	N/A	N/A
203	Frisco Elementary #18 - Shaddock	collin	post 2007	N/A	N/A
204	Shiver Road Elementary #18 Keller ISD	Tarrant	post 2007	N/A	N/A
205	Woodland Springs Elementary #17 Keller ISD	Tarrant	post 2007	N/A	N/A
206	McDonwell Elementary (Keller ISD)	Tarrant	post 2007	N/A	N/A
207	Keller Intermediate School #5 Keller ISD	Tarrant	post 2007	N/A	N/A
208	Shady Shores Elementary	Denton	post 2007	N/A	N/A
209	Alta Vista Middle School #5 Keller ISD	Tarrant	post 2007	N/A	N/A
210	Brewer High School (White Settlement ISD)	Tarrant	post 2007	N/A	N/A
211	Leaky High school	Gillespie	N/A	120	N/A
212	Canutillo High School	El Paso	N/A	1200	N/A
213	Lubbock Christian University	Lubbock	N/A	N/A	N/A
214	Rice University	Harris	N/A	N/A	N/A

Table 6-9: Landfill Gas-Fired Power Plants: Operational.

Project No	Landfill Name	City	County	Waste In Place (tons)	Landfill Owner Organization	Project Status	Project Start Date	MW Capacity	LFG Flow to Project (SCFD)	Emission Reductions (MTCO2)
1	McCarty Road LF	Houston	Harris	28,918,718	Allied Waste Services	Operational	1/1/1986	N/A	N/A	0.797
2	DFW Gas Recovery	Lewisville	Denton	N/A	WM Renewable Energy LLC	Operational	May-88	3	N/A	N/A
3	DFW Gas Recovery	Lewisville	Denton	N/A	WM Renewable Energy LLC	Operational	May-88	3	N/A	N/A
4	Dallas-Fort Worth LF	Dallas	Denton	18,388,100	Waste Management, Inc.	Operational	1/1/1992	6.6	N/A	0.286
5	Sunset Farms	Austin	Travis	N/A	Gas Recovery Systems Inc	Operational	Dec-96	1	N/A	N/A
6	Sunset Farms	Austin	Travis	N/A	Gas Recovery Systems Inc	Operational	Dec-96	1	N/A	N/A
7	Sunset Farms	Austin	Travis	N/A	Gas Recovery Systems Inc	Operational	Dec-96	1	N/A	N/A
8	Sunset Farms	Austin	Travis	9,600,000	Allied Waste Services	Operational	12/1/1996	3	1.5	0.13
9	Austin Community LF	Austin	Travis	10,380,188	Waste Management, Inc.	Shutdown	1/1/1998	N/A	N/A	N/A
10	City of Brownwood Landfill	Brownwood	Brown	1,300,100	City of Brownwood	Operational	1/1/1998	N/A	N/A	0.035
11	McCommas Bluff LF/City of Dallas	Dallas	Dallas	26,470,000	City of Dallas, TX	Operational	1/1/2000	N/A	N/A	0.772
12	Rosenberg Landfill	Rosenberg	Fort Bend	2,649,100	Fort Bend County, TX	Operational	1/1/2000	N/A	1	0.082
13	Castle Road Landfill	Garland	Dallas	4,012,500	City of Garland	Operational	5/1/2000	N/A	N/A	0.089
14	Arlington LF	Arlington	Tarrant	13,981,144	City of Arlington	Operational	6/1/2001	5	1.584	0.217
15	BFI - Tessman Road Landfill	San Antonio	Bexar	11,300,000	Allied Waste Services	Operational	10/10/2002	5.4	2.9	0.234
16	Coastal Plains LF	Alvin	Galveston	6,546,410	Waste Management, Inc.	Operational	1/10/2003	6.7	N/A	0.289
17	Sanifill Of Texas-Baytown LF	Baytown	Chambers	6,290,000	Waste Management, Inc.	Operational	1/24/2003	3.9	1.73	0.169
18	Blue Bonnet LF	Houston	Harris	2,526,000	Waste Management, Inc.	Operational	3/1/2003	1.9	0.928	0.084
19	City of Conroe LF	Conroe	Montgomery	3,146,000	City of Conroe	Operational	3/1/2003	2.9	N/A	0.126
20	Atascosita	Atascosita	Harris	N/A	Viridis Energy	Operational	3-Mar	1.3	N/A	N/A
21	Atascosita	Atascosita	Harris	N/A	Viridis Energy	Operational	3-Mar	1.3	N/A	N/A
23	Atascosita	Atascosita	Harris	N/A	Viridis Energy	Operational	3-Mar	1.3	N/A	N/A
24	Atascosita	Atascosita	Harris	N/A	Viridis Energy	Operational	3-Mar	1.3	N/A	N/A
25	Coastal Plains	Alvin	Galveston	N/A	Viridis Energy	Operational	3-Mar	1.3	N/A	N/A
26	Coastal Plains	Alvin	Galveston	N/A	Viridis Energy	Operational	3-Mar	1.3	N/A	N/A
27	Coastal Plains	Alvin	Galveston	N/A	Viridis Energy	Operational	3-Mar	1.3	N/A	N/A
28	Coastal Plains	Alvin	Galveston	N/A	Viridis Energy	Operational	3-Mar	1.3	N/A	N/A
29	BFI - Tessman Road Landfill	San Antonio	Bexar	11,300,000	Allied Waste Services	Operational	5/1/2003	2.7	1.45	0.117
30	Security Recycling and Disposal LF	Cleveland	Montgomery	4,014,800	Waste Management, Inc.	Operational	5/1/2003	5	N/A	0.217

Table 6-9: Landfill Gas-Fired Power Plants: Operational (cont'd.).

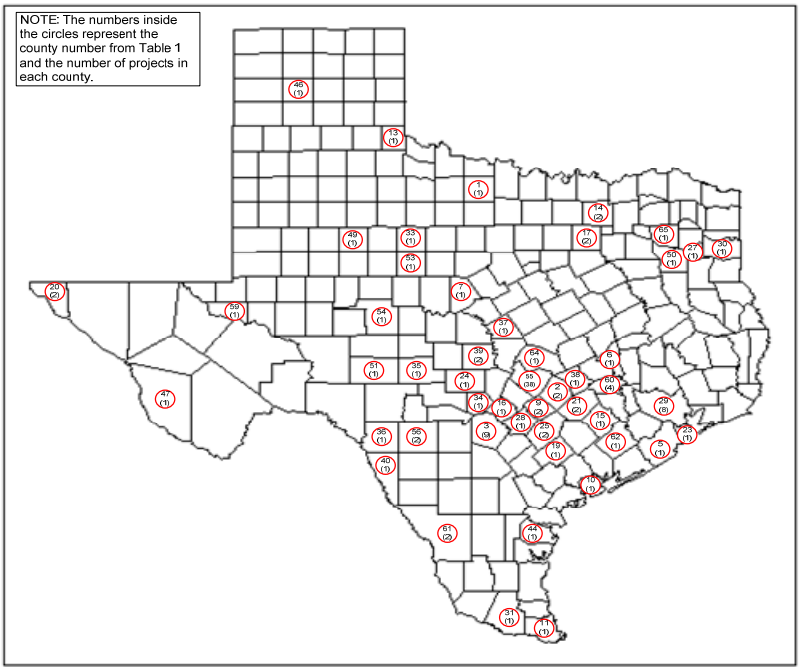
Project No	Landfill Name	City	County	Waste In Place (tons)	Landfill Owner Organization	Project Status	Project Start Date	MW Capacity	LFG Flow to Project (SCFD)	Emission Reductions (MTCO2)
31	BFI Tessman Rd Landfill	San Antonio	Bexar	N/A	Energy Developments Inc	Operational	3-May	1.4	N/A	N/A
32	WMI/Atascocita LF	Humble	Harris	9,628,700	Waste Management, Inc.	Operational	6/1/2003	8.5	3.09	0.368
33	Bluebonnet	Houston	Harris	N/A	Viridis Energy	Operational	3-Aug	1	N/A	N/A
34	Bluebonnet	Houston	Harris	N/A	Viridis Energy	Operational	3-Aug	1	N/A	N/A
35	Bluebonnet	Houston	Harris	N/A	Viridis Energy	Operational	3-Aug	1	N/A	N/A
36	Bluebonnet	Houston	Harris	N/A	Viridis Energy	Operational	3-Aug	1	N/A	N/A
37	Conroe	Conroe	Montgomery	N/A	Viridis Energy	Operational	3-Aug	1	N/A	N/A
38	Conroe	Conroe	Montgomery	N/A	Viridis Energy	Operational	3-Aug	1	N/A	N/A
39	Conroe	Conroe	Montgomery	N/A	Viridis Energy	Operational	3-Aug	1	N/A	N/A
40	Baytown	Baytown	Chambers	N/A	Viridis Energy	Operational	3-Dec	1.3	N/A	N/A
41	Baytown	Baytown	Chambers	N/A	Viridis Energy	Operational	3-Dec	1.3	N/A	N/A
42	Security	Houston	Montgomery	N/A	Viridis Energy	Operational	3-Dec	1.3	N/A	N/A
43	Security	Houston	Montgomery	N/A	Viridis Energy	Operational	3-Dec	1.3	N/A	N/A
45	Sunset Farms	Austin	Travis	N/A	Gas Recovery Systems Inc	Operational	4-Jan	1	N/A	N/A
46	WMI/Atascocita LF	Humble	Harris	9,628,700	Waste Management, Inc.	Operational	1/1/2004	1.7	0.62	0.074
47	City of Austin LF	Austin	Travis	4,858,500	City of Austin, TX	Operational	2/1/2004	0.2	N/A	0.009
48	City of Waco LF	Woodway	McLennan	2,225,000	City of Waco	Operational	3/1/2004	1.5	1	0.065
49	Atascosita	Atascosita	Harris	N/A	Viridis Energy	Operational	4-Jul	1.7	N/A	N/A
50	Denton Sanitary Landfill	Denton	Denton	2,266,664	City of Denton, TX	Operational	2/1/2005	N/A	0.432	0.035
51	Covel Gardens LF	San Antonio	Bexar	12,007,000	Waste Management, Inc.	Operational	12/1/2005	9.6	N/A	0.416
52	Fort Worth Regional LF	Haltom City	Tarrant	N/A	Allied Waste Services	Construction	3/15/2006	1.6	0.72	0.069
53	McCommas Bluff LF/City of Dallas	Dallas	Dallas	26,470,000	City of Dallas, TX	Construction	7/1/2006	22	N/A	0.953
54	Denton Sanitary Landfill	Denton	Denton	2,266,664	City of Denton, TX	Construction	9/1/2006	1.5	0.86	0.065

Table 6-10: Landfill Gas-Fired Power Plants: Candidates.

Proj. No	Landfill Name	County	Waste In Place (tons)	Year Landfill Opened	Landfill Closure Year	Landfill Owner Organization
1	Skyline LF	Ellis	8,191,000	1942	2040	Waste Management, Inc.
2	Trinity Oaks Landfill	Dallas	6,838,600	1969	2003	Allied Waste Services
3	J.C. Elliot LF	Nueces	5,717,100	1972	2005	City of Corpus Christi, TX
4	Galveston County LF	Galveston	7,822,500	1973	2025	Allied Waste Services
5	Mill Creek LF	Tarrant	4,815,500	1973	2002	Allied Waste Services
6	City of Lubbock LF	Lubbock	2,177,800	1975	2008	City of Lubbock
7	City of Pampa LF	Gray	1,176,200	1975	2007	City of Pampa
8	Colorado City Landfill	Mitchell	1,545,200	1975	2020	City of Colorado City
9	Comal County LF	Comal	3,817,620	1975	2010	Waste Management, Inc.
10	Amarillo LF	Potter	7,031,400	1976	2050	City of Amarillo
11	C&T Landfill	Hidalgo	3,844,000	1976	2004	Duncan Disposal, Inc.
12	City Of Sweetwater LF	Nolan	1,283,800	1976	2040	City of Sweetwater
13	City Of Weatherford LF	Parker	1,079,000	1976	2060	IESI, Inc.
14	Fort Worth Southeast Landfill	Tarrant	5,299,400	1976	2036	City of Fort Worth, TX
15	SLF	Colorado	1,980,400	1976	2002	Safety Clean
16	Austin Community LF	Travis	10,380,188	1977	2001	Waste Management, Inc.
17	City of Grand Prairie LF	Dallas	2,835,800	1977	2021	City of Grand Prairie
18	City of Nacogdoches Landfill	Nacogdoches	1,296,200	1977	2033	City of Nacogdoches
19	Westside Sanitary LF	Tarrant	9,955,600	1977	2005	Waste Management, Inc.
20	Whispering Pines LF	Harris	6,405,000	1978	2017	Allied Waste Services
21	City of Perryton Landfill	Ochiltree	1,631,100	1979	2006	City of Perryton
22	City of McKinney LF	Collin	3,957,000	1980	2004	City of McKinney
23	Nelson Gardens LF	Bexar	11,800,000	1980	1993	City of San Antonio
24	Camelot Landfill	Denton	6,044,700	1981	2019	City of Farmers Branch
25	City of Irving Landfill	Dallas	2,063,900	1981	2065	City of Irving, TX
26	Hillside Landfill	Grayson	2,526,400	1981	2023	Waste Management, Inc.
27	Sprint Fort Bend County LF	Fort Bend	1,664,372	1981	2020	The Sprint Companies
28	Williamson County LF	Williamson	2,134,700	1981	2040	Waste Management, Inc.
29	BFI - Abilene Landfill	Jones	7,921,300	1982	2067	Ray Knowles
30	City of Victoria Landfill	Victoria	2,556,000	1982	2040	City of Victoria
31	City of Wichita Falls LF	Wichita	4,073,200	1982	2021	City of Wichita Falls
32	North Texas Waste/Maxwell Creek LF	Collin	6,083,700	1982	2004	District
33	Pine Hill LF	Gregg	12,141,700	1982	2060	4S Oil Company
34	City of Beaumont LF	Jefferson	2,868,800	1983	2021	City of Beaumont
35	Clint LF	El Paso	4,904,400	1983	2006	City of El Paso
36	Royal Oaks Landfill	Cherokee	1,044,200	1983	2030	Allied Waste Services
37	Turkey Creek LF	Johnson	3,733,200	1983	2025	Allied Waste Services
38	McCombs LF	El Paso	4,137,100	1984	2046	City of El Paso
39	CSC Disposal and Landfill	Ellis	4,254,250	1985	2100	Republic Services, Inc.
40	Lacy-Lakeview LF	McLennan	1,306,200	1985	2020	Waste Management, Inc.
41	City of Laredo LF	Webb	3,180,000	1986	2015	City of Laredo
42	City of Port Arthur Landfill	Jefferson	1,802,100	1986	2044	City of Port Arthur
43	Southwest Landfill (Amarillo)	Randall	3,393,200	1987	2025	Allied Waste Services
44	Sprint LF	Harris	2,041,600	1987	2005	Landfill Owner
45	Altair Disposal Services LLC	Colorado	9,195,000	1988	2004	Clean Harbors
46	Greenwood Farms Landfill	Smith	3,087,300	1989	2020	City of Tyler
47	Texas Disposal Systems LF	Travis	4,408,900	1990	2050	Texas Disposal Systems
48	Golden Triangle Landfill	Jefferson	2,310,400	1991	2021	Allied Waste Services
49	Blue Ridge LF	Fort Bend	4,113,900	1993	2025	Allied Waste Services
50	Brazoria County Disposal LF	Brazoria	6,279,700	1993	2050	Republic Services, Inc.
51	WMI/E & D Waste Systems Inc. LF	Galveston	3,202,900	1994	2022	Waste Management, Inc.
52	Charter Waste Landfill	Ector	1,300,000	N/A	N/A	Republic Services, Inc.
53	City of Temple Landfill	Bell	3,600,000	N/A	N/A	City of Temple
54	Eastside Landfill	Tarrant	N/A	N/A	N/A	Waste Management, Inc.

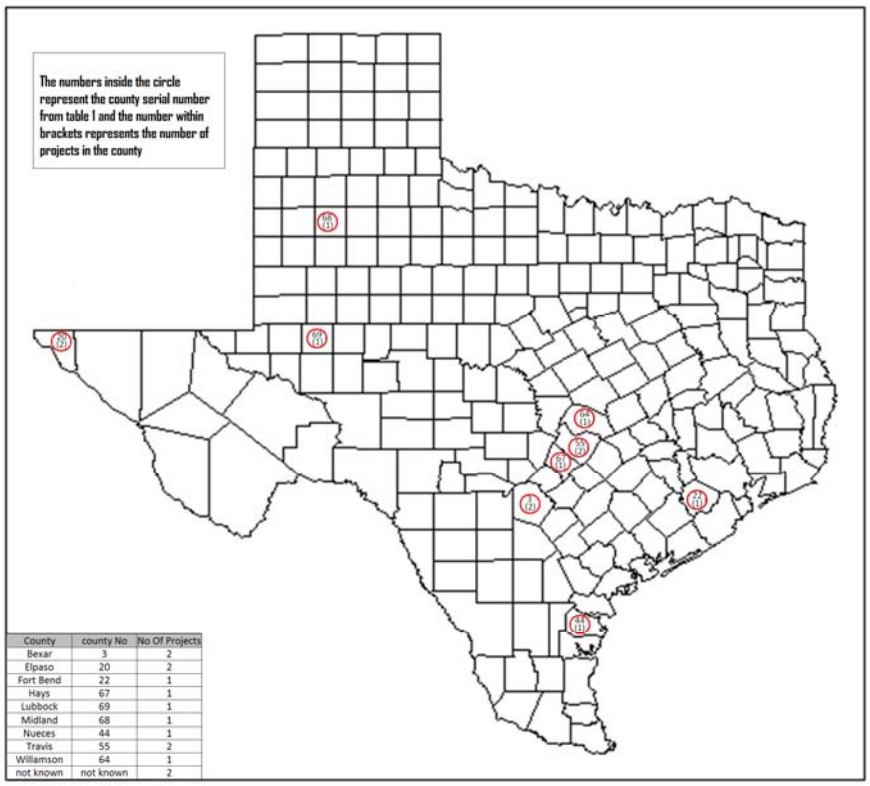
Table 6-11: Landfill Gas-Fired Power Plants: Potential.

Proj. No.	Landfill Name	City	County	(tons)	Opened	Closure Year	Landfill Owner Organization
1	Pleasant Oaks Landfill	Mount Pleasant	Titus	N/A	1960	2012	City of Mount Pleasant
2	Sinton	Sinton	San Patricio	N/A	1972	2002	Allied Waste Services
3	City of Richardson LF	Richardson	Collin	825,218	1975	1990	City of Richardson
4	City of Cleburne Landfill	Cleburne	Johnson	1,583,200	1976	N/A	Landfill Owner
5	Itasca Landfill	Itasca	Hill	N/A	1977	2017	Allied Waste Services
6	Quail Canyon	Lubbock	Lubbock	200,200	1977	1993	Allied Waste Services
7	Hutchins Landfill	Hutchins	Dallas	1,000,000	1978	1992	Allied Waste Services
8	Maloy Landfill	Commerce	Hunt	610,000	1979	2030	Republic Services, Inc.
9	Mexia Landfill	Mexia	Limestone	N/A	1983	2019	Allied Waste Services
10	Pecan Prairie Landfill	Kingston	Hunt	1,479,900	1984	1998	Waste Management, Inc.
11	Trashaway San Angelo Landfill	San Angelo	Tom Green	790,000	1984	N/A	Republic Services, Inc.
12	Kerrville Landfill	Kerrville	Kerr	N/A	1985	2006	City of Kerrville
13	Lewisville Landfill	Lewisville	Denton	N/A	1986	2003	Allied Waste Services
14	ECD Landfill	Ennis	Ellis	N/A	1988	2089	Allied Waste Services
15	Bell Processing Inc. LF	Wichita Falls	Wichita	N/A	1990	2001	Bell Processing Inc
16	Laidlaw/Wilmer LF	Wilmer	Dallas	686,400	1992	2001	Landfill Owner
17	BFI LF	Abilene	Taylor	745,888	1993	1997	Pine Street Salvage Company
18	City of Corsicana LF	Corsicana	Navarro	788,100	1993	2100	Landfill Owner
19	Gulfwest Facility	Anahuac	Chambers	N/A	1993	2017	Allied Waste Services
20	Bell County/Sparks LF	Belton	Bell	343,200	1994	2001	Bell County
21	Ellis County LF	Palmer	Ellis	892,320	1994	N/A	Waste Management, Inc.
22	El Centro Landfill	Robstown	Nueces	N/A	2000	2013	Allied Waste Services
23	Best Pak Disposal Inc. LF	Pattison	Waller	N/A	N/A	2001	Waste Management, Inc.
24	Hazelwood Enterprises, Inc. LF	N/A	N/A	N/A	N/A	N/A	Landfill Owner
25	New Boston Landfill	New Boston	Bowie	N/A	N/A	N/A	N/A
26	Newton County Landfill	Mauriceville	Newton	N/A	N/A	N/A	N/A
27	North County C&D Landfill	League City	Galveston	N/A	N/A	N/A	Republic Services, Inc.
28	Paris Landfill	Paris	Lamar	N/A	N/A	N/A	N/A
29	Rio Grande Valley	Donna	Hidalgo	N/A	N/A	N/A	Allied Waste Services



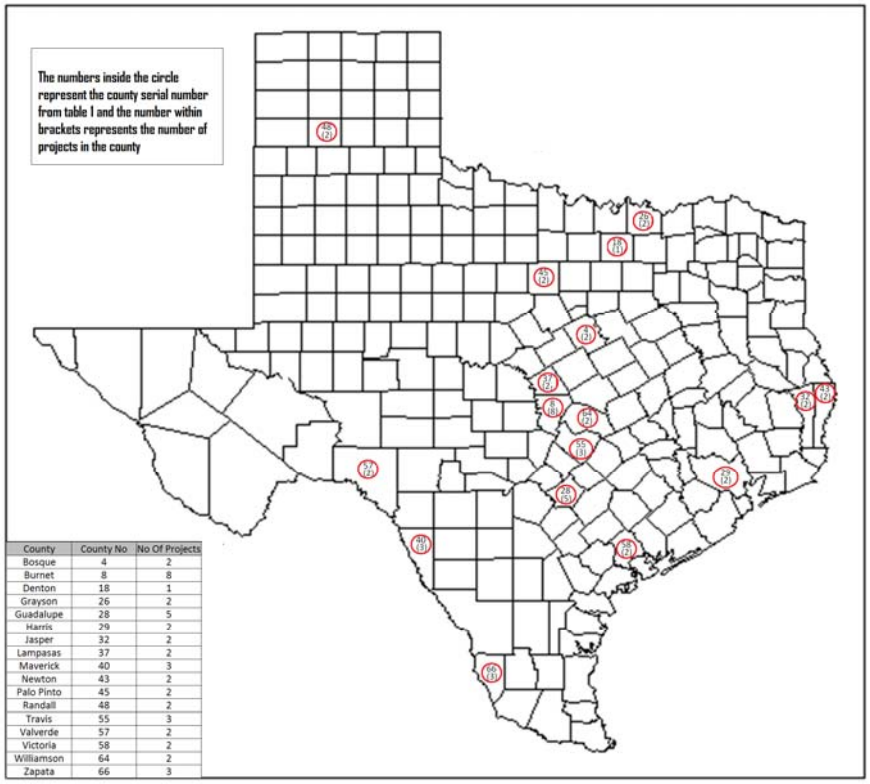
County	County No	No Of Projects		County	County No	No Of Projects
Archer	1	1		Jones	33	1
Bastrop	2	2		Kendall	34	1
Bexar	3	9		Kimble	35	1
Brazoria	5	1		Kinney	36	1
Brazos	6	1		Lampasas	37	1
Brown	7	1		Lee	38	1
Caldwell	9	2		Llano	39	2
Calhoun	10	1		Maverick	40	1
Cameron	11	1		Nueces	44	1
Childress	13	1		Potter	46	1
Collin	14	2		Presidio	47	1
Colorado	15	1		Scurry	49	1
Comal	16	1		Smith	50	1
Dallas	17	2		Sutton	51	1
DeWitt	19	1		Taylor	53	1
El Paso	20	2		Tom Green	54	1
Fayette	21	2		Travis	55	38
Galveston	23	1		Uvalde	56	2
Gillespie	24	1		Ward	59	1
Gonzales	25	2		Washington	60	4
Gregg	27	1		Webb	61	2
Guadalupe	28	1		Wharton	62	1
Harris	29	8		Williamson	64	1
Harrison	30	1		Wood	65	1
Hidalgo	31	1				

Figure 6-1: Solar Photovoltaic Projects throughout Texas.



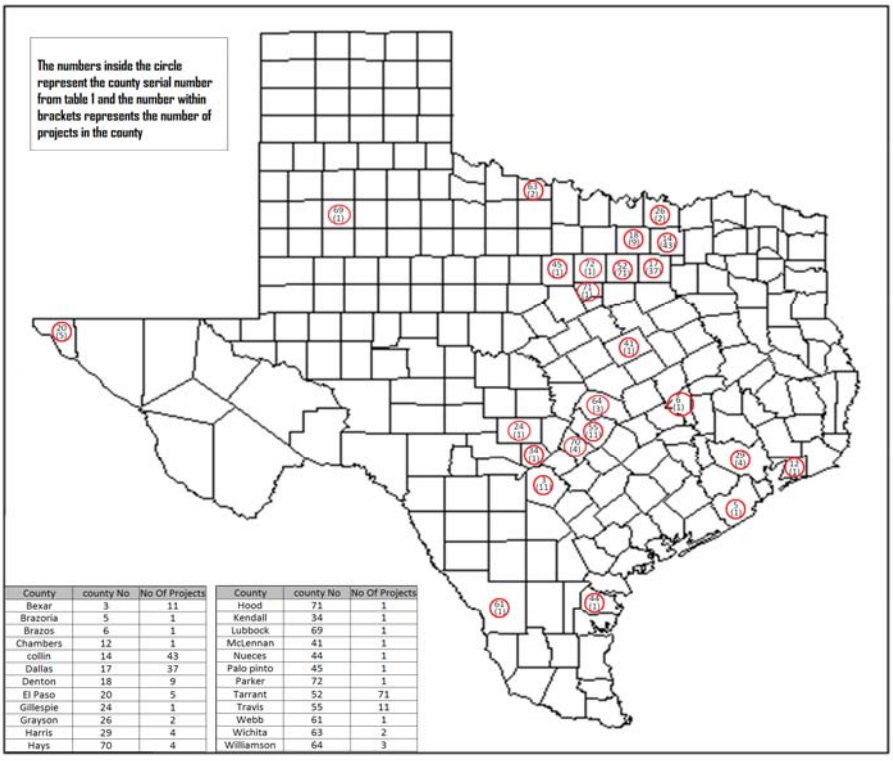
County	county No	No Of Projects
Bexar	3	2
Elpaso	20	2
Fort Bend	22	1
Hays	67	1
Lubbock	69	1
Midland	68	1
Nueces	44	1
Travis	55	2
Willamson	64	1
not known	not known	2

Figure 6-2: Solar Thermal Projects throughout Texas.



County	County No	No Of Projects
Bosque	4	2
Burnet	8	8
Denton	18	1
Grayson	26	2
Guadalupe	28	5
Harris	29	2
Jasper	32	2
Lampasas	37	2
Maverick	40	3
Newton	43	2
Palo Pinto	45	2
Randall	48	2
Travis	55	3
Valverde	57	2
Victoria	58	2
Williamson	64	2
Zapata	66	3

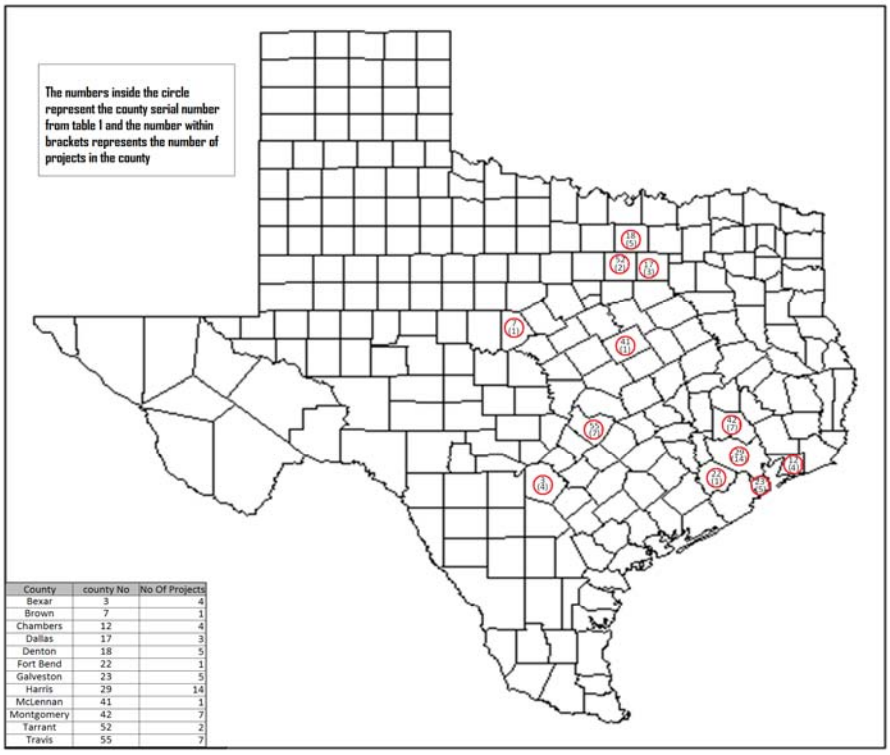
Figure 6-3: Hydropower Plants throughout Texas.



County	county No	No Of Projects
Bexar	3	11
Brazoria	5	1
Brazos	6	1
Chambers	12	1
collin	14	43
Dallas	17	37
Denton	18	9
El Paso	20	5
Gillespie	24	1
Grayson	26	2
Harris	29	4
Hays	70	4

County	county No	No Of Projects
Hood	71	1
Kendall	34	1
Lubbock	69	1
McLennan	41	1
Nueces	44	1
Palo pinto	45	1
Parker	72	1
Tarrant	52	71
Travis	55	11
Webb	61	1
Wichita	63	2
Williamson	64	3

Figure 6-4: Geothermal Projects Installed throughout Texas.



County	county No	No Of Projects
Bexar	3	4
Brown	7	1
Chambers	12	4
Dallas	17	3
Denton	18	5
Fort Bend	22	1
Galveston	23	5
Harris	29	14
McLennan	41	1
Montgomery	42	7
Tarrant	52	2
Travis	55	7

Figure 6-5: Landfill Gas-Fired Power Projects Installed throughout Texas.

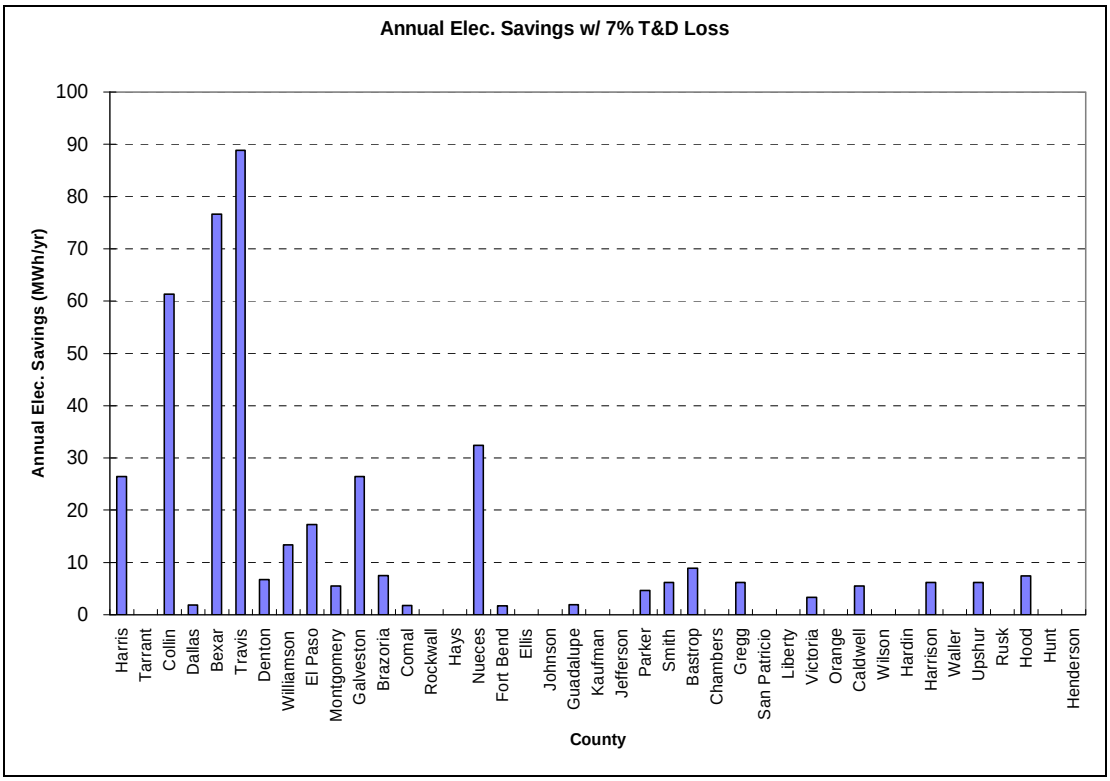


Figure 6-6: Annual Electric Savings per County from PV Projects.

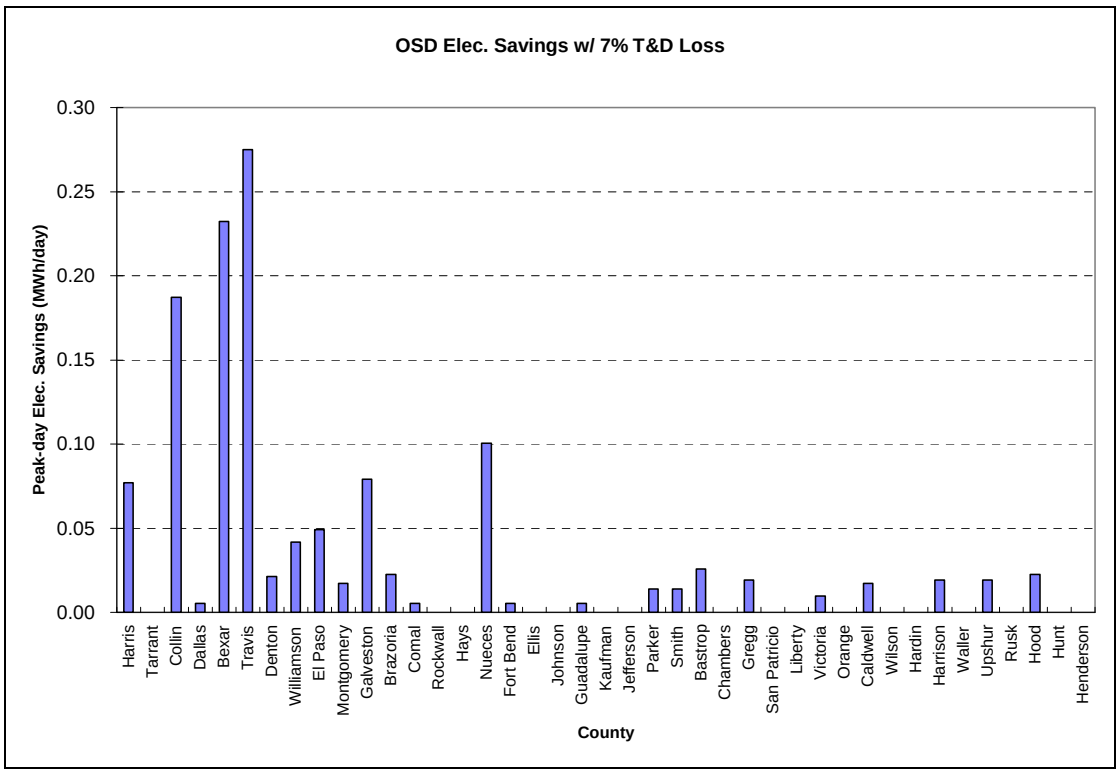


Figure 6-7: Ozone Season Day Electric Savings per County from PV Projects.

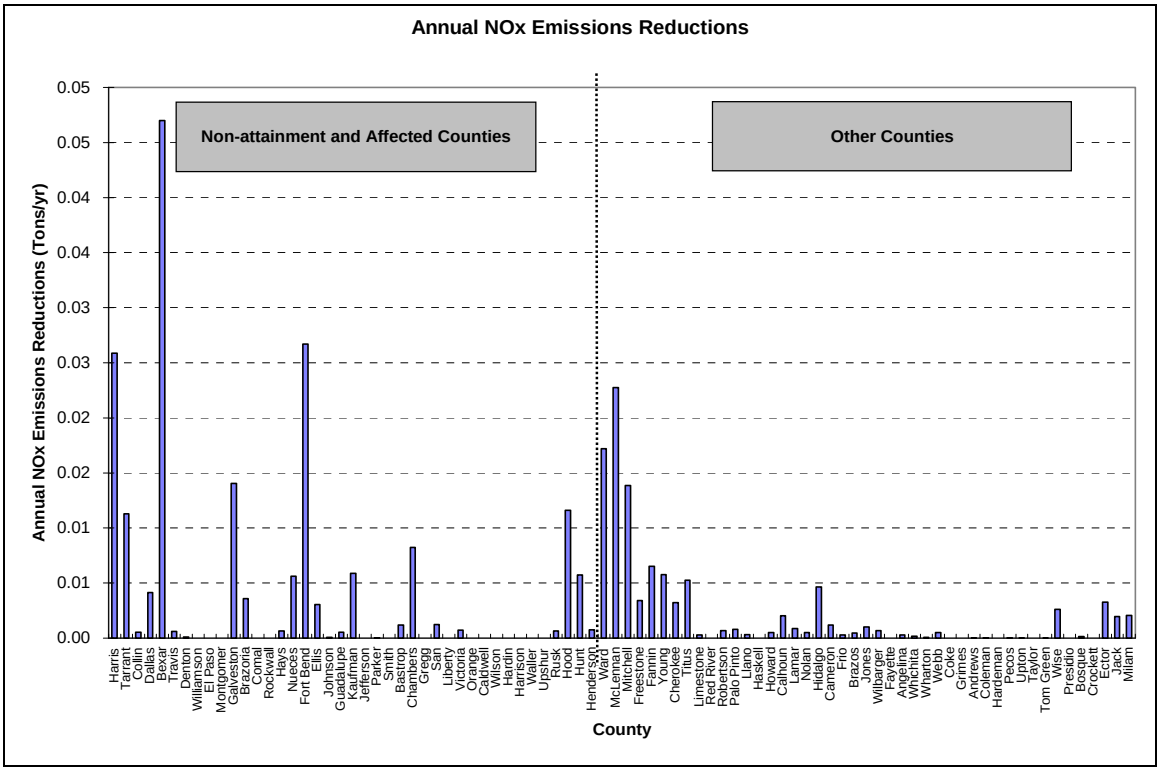


Figure 6-8: NOx Emissions Reductions per County from PV Projects.

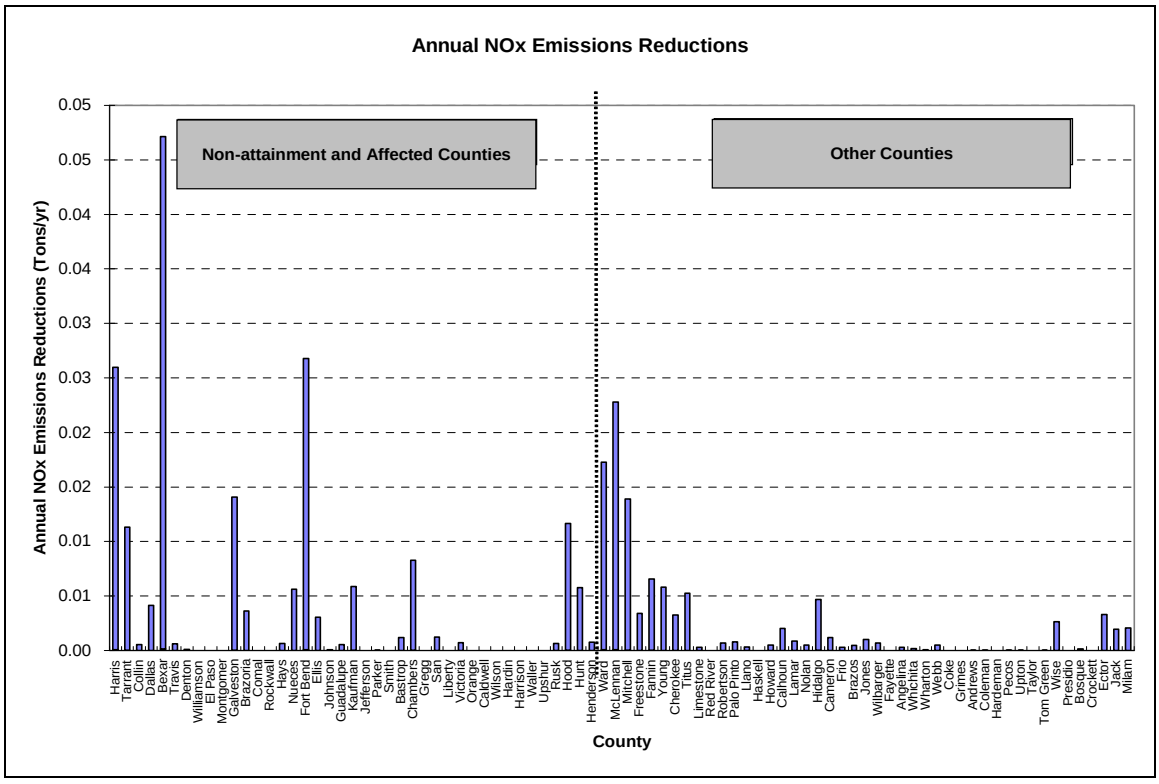


Figure 6-9: Ozone Season Day NOx Emissions Reductions per County from PV Projects.

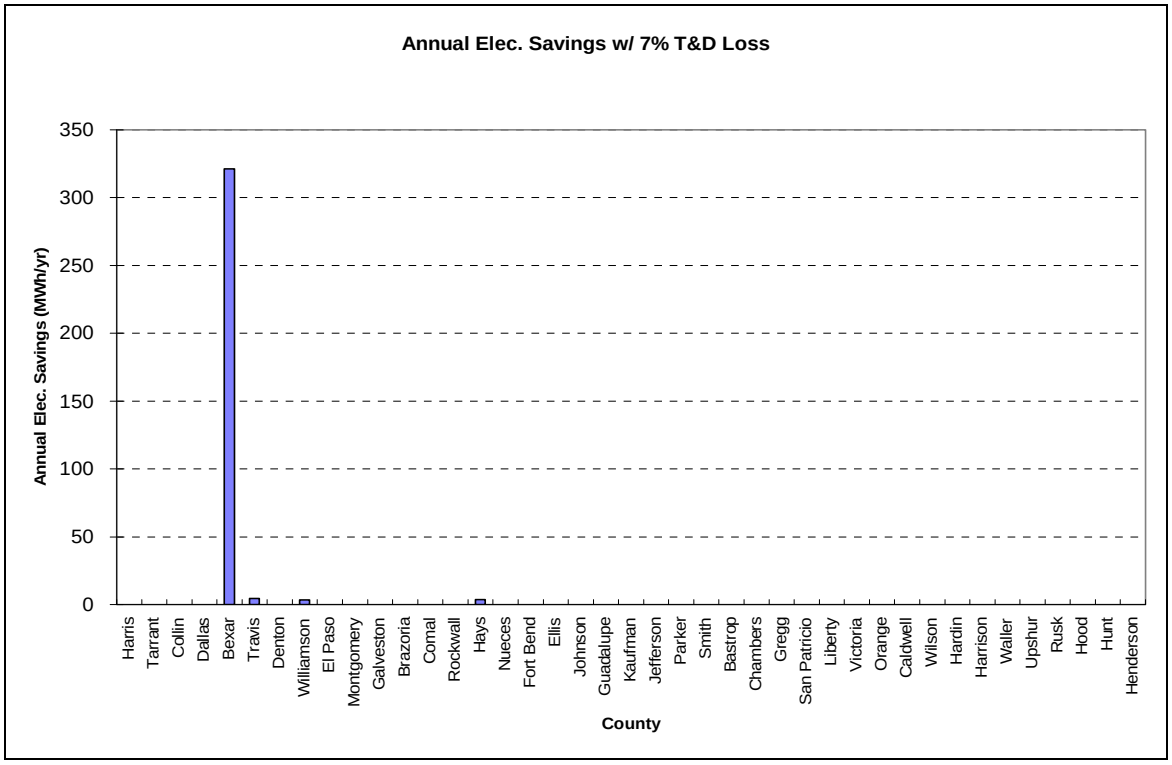


Figure 6-10: Annual Electric Savings per County from Solar Thermal Projects.

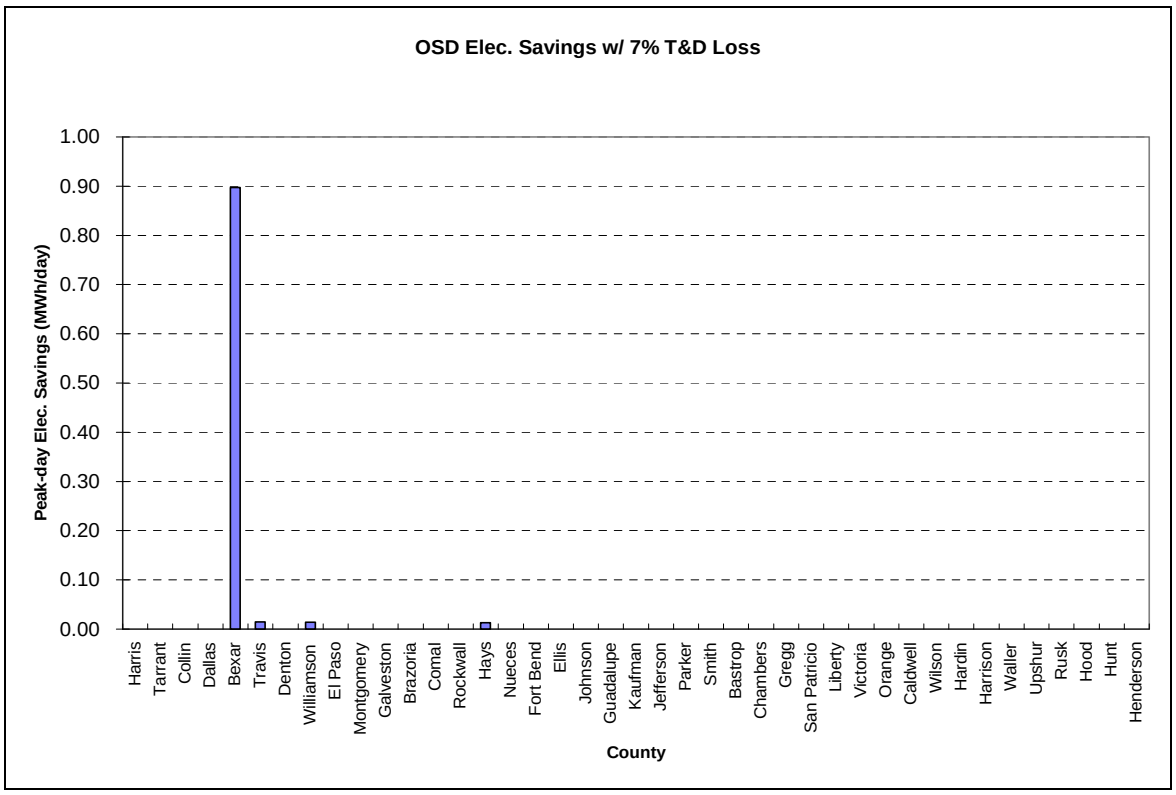


Figure 6-11: Ozone Season Day Electric Savings per County from Solar Thermal Projects.

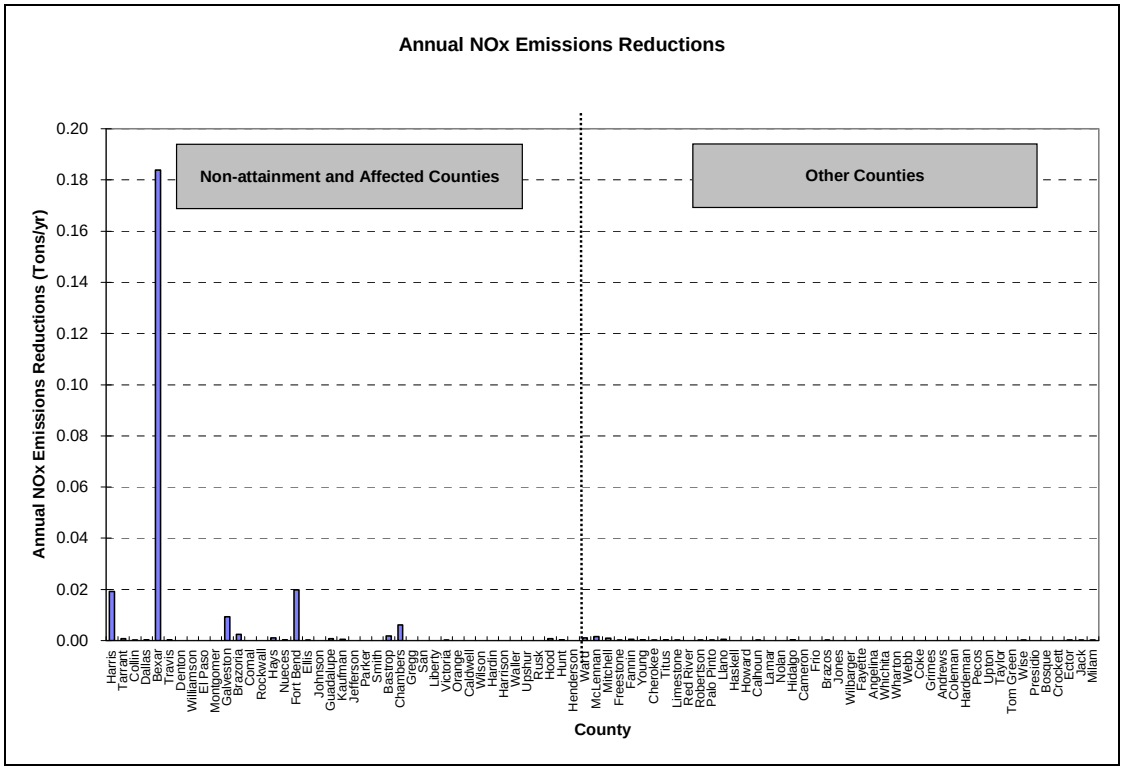


Figure 6-12*:* NOx Emissions Reductions per County from Solar Thermal Projects.

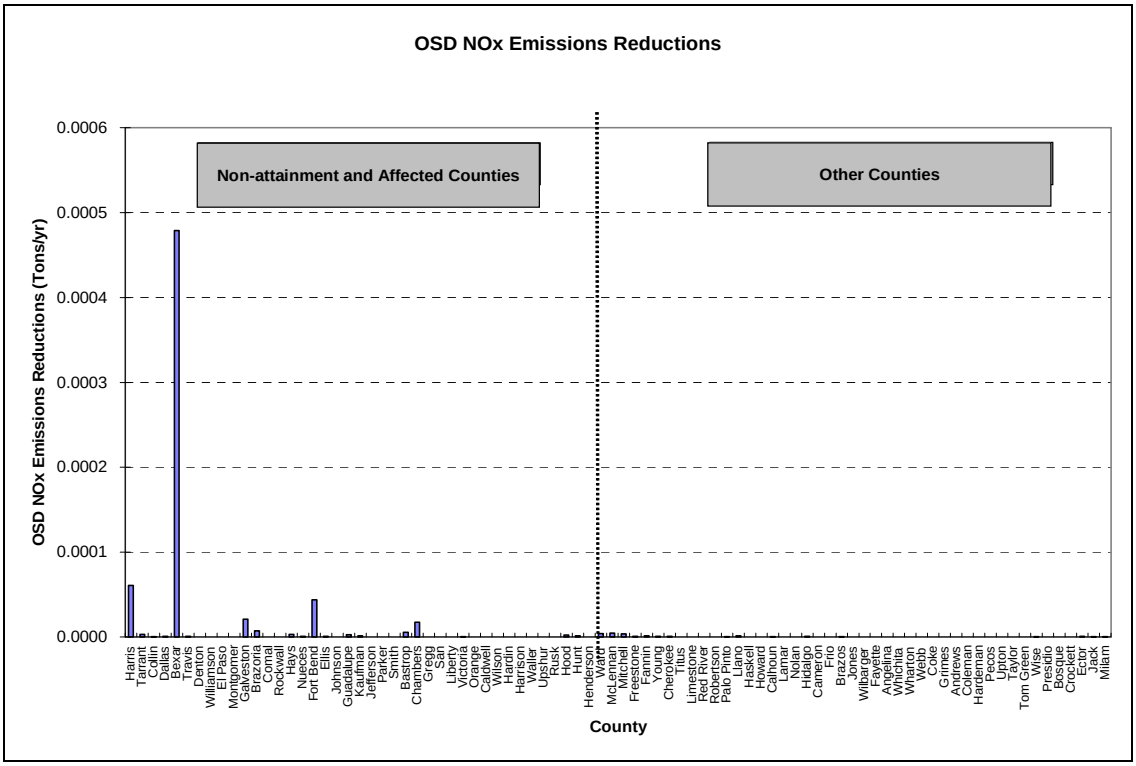


Figure 6-13: Ozone Season Day NOx Emissions Reduction per County from Solar thermal projects.

7 REVIEW OF ERCOT'S RENEWABLE ENERGY CREDIT PROGRAM INFORMATION

7.1 Introduction

In this section, the information posted on ERCOT's Renewable Energy Credit Program site www.texasrenewables.com was reviewed for use in the ESL's report to the TCEQ. In particular, information posted under the "Public Reports" tab was downloaded and assembled into an appropriate format for review. This includes ERCOT's 2001 through 2007 reports to the Legislature, which were converted into tabular format for analysis and inserted into this report. Similarly, information from ERCOT's listing of REC generators was inspected to determine how it compared with other sources of information the ESL has assembled. Table 7-1 to Table 7-5 contains the list of REC generators that ERCOT has assembled till the end of 2007.

7.2 Summary of Renewable Projects in Texas

Each year ERCOT is required to compile a list of grid-connected sources that generate electricity from renewable energy and report to the Legislature. Table 7-6 contains the data reported by ERCOT from 2001 through 2007 and Table 7-7 summarizes the same. Figure 7-1, Figure 7-2 and Figure 7-3 have been included to better illustrate the annual data collected by ERCOT. In the figures and tables it is clear to see that the electricity generated by wind each year is the largest single source of renewable energy in Texas, which has grown from 565,597 MWh in 2001 to 9,339,756 MWh in 2007. This is followed by landfill gas, which has grown from 29,412 MWh in 2002 to 356,339 MWh in 2007; hydroelectric: 30,639 (2001) to 382,882 (2007); biomass: 39,496 MWh (2003) to 51,823 MWh in 2007, with a peak of 60,569 in 2006; and lastly solar: 87 MWh (2002) to 1844 MWh (2007).

Table 7-1: ERCOT REC Generator List – Biomass.

Company Name	Power Generating Company Name	Power Generating Company Code	Generator Site Name	Generator Site Code	Facility Identification Number	Unit Contact Information	Technology Type	Facility Noncompetitive Certification Data
Bio Energy (Austin) LLC	Bio Energy Austin LLC	DG_WALZE	DG_WALZE	DG_WALZE	38	Dennis Bollinger	Biomass	25512
MeadWestvaco Texas LP	MeadWestvaco Texas LP	Evadale Opertions	Evadale Pulp and Paper Mill	Evadale Texas	63	Angela Robinson	Biomass	31646
Rio Grande Valley Sugar Growers, Inc.	RGVSugar	RGVSugar	RGVSugar	RGVSugar	97	Steve Bearden	Biomass	33421
Snider Industries, LLP	Snider Industries, LLP	Snider_1	Snider_1	Snider_1	109	Julianna Parr	Biomass	35526

Table 7-2: ERCOT REC Generator List – Hydro.

Company Name	Power Generating Company Name	Power Generating Company Code	Generator Site Name	Generator Site Code	Facility Identification Number	Unit Contact Information	Technology Type	Facility Noncompetitive Certification Data
Guadalupe-Blanco River Authority	Guadalupe-Blanco River Authority	05-631-1608-3000	DG_Schumansville	DG_Schum	3	Allen Ognoskie	Hydro	20028
Guadalupe-Blanco River Authority	Guadalupe-Blanco River Authority	05-631-1608-3000	DG-MCQUEENEY	DG_MCQUE	4	Allen Ognoskie	Hydro	20028
Small Hydro of Texas, Inc.	Small Hydro of Texas, Inc.	71	DG_CUERO CSW	CUECPL	13	Linda A. Parker	Hydro	24191
Maverick County Water Control	Maverick County Water	Maverick County	Maverick County Water	20141	92	Maverick County Water	Hydro	34674

Table 7-3: ERCOT REC Generator List – Solar.

Company Name	Power Generating Company Name	Power Generating Company Code	Generator Site Name	Generator Site Code	Facility Identification Number	Unit Contact Information	Technology Type	Facility Noncompetitive Certification Data
Renewable Ventures	Nuon Renewable Ventures	NRV	Green Mountain Solar at Upper Kirby	USAPV003	19	Nuon Renewable Ventures	Solar	26410
Renewable Ventures	Nuon Renewable Ventures	NRV	Green Mountain Solar at The Winston School	USAPV002	20	Nuon Renewable Ventures	Solar	26411
The University of Texas - Houston	University of Texas - Houston	UTHSC	University Center Tower	University Center Tower	42	Rahsaan Arscott	Solar	No. 77027

Table 7-4: ERCOT REC Generator List – Landfill Gas.

Company Name	Power Generating Company Name	Power Generating Company Code	Generator Site Name	Generator Site Code	Facility Identification Number	Unit Contact Information	Technology Type	Facility Noncompetitive Certification Data
Viridis Energy, LP Atascocita	Viridis Energy, LP - Atascocita	93-01-87393	ATASCOCITA	HB	29	Mr Luong Nguyen	Landfill gas	26813
Viridis Energy, LP - Coastal Plains	Viridis Energy, LP - Coastal Plains	93-01-16145	COASTAL PLAINS	ALVIN	32	Mr Luong Nguyen	Landfill gas	26812
Viridis Energy, LP - Baytown	Viridis Energy, LP - Baytown	01-62-16561	BAYTOWN	TRM	33	Mr Luong Nguyen	Landfill gas	26811
Viridis Energy, LP - Blue Bonnet	Viridis Energy, LP - Blue Bonnet	93-01-27472	BLUE BONNET	LB	34	Mr Luong Nguyen	Landfill gas	26809
Viridis Energy, LP - Conroe	Viridis Energy, LP - Conroe	Conroe	Conroe	Conroe	35	Mr Luong Nguyen	Landfill gas	26808
Viridis Energy, LP - Security	Viridis Energy, LP - Security	SECURITY	SECURITY	SECURITY	36	Mr Luong Nguyen	Landfill gas	26810
Gas Recovery Systems, Inc.	Gas Recovery Systems	20066	Sunset Farms Electric	Sunset Farms Electric	37	Paul Hesson	Landfill gas	24199
Renovar Arlington, Ltd.	Renovar Arlington, Ltd.	Rnvr-1	Village Creek	Vcreek	53	Lisette Cowger	Landfill gas	31083
Renovar Arlington, Ltd.	Renovar Arlington, Ltd.	Rnvr-2	Village Creek	Vcreek	54	Lisette Cowger	Landfill gas	31083
Bio Energy (Texas), LLC	Bio Energy (Texas) LLC	32079	Covel Gardens Landfill Gas Power Station	DG_MEDIN	61	John M. Love	Landfill gas	20140
G2 Energy (FW Regional)	G2 Energy (FW Regional) LLC	77-998-1765	DG_RDLML_1 Unit	FW Regional	64	John Bean	Landfill gas	32558
WM Renewable Energy, LLC	WM Renewable Energy, L.L.C.	Skyline	Skyline	DG_FERIS	83	Scott Burnell	Landfill gas	20161
WM Renewable Energy, LLC	WM Renewable Energy II, LLC	Austin	Austin	DG_SPRIN	95	Steven Korsgaard	Landfill gas	20161

Table 7-5: ERCOT REC Generator List – Wind.

Company Name	Power Generating Company Name	Power Generating Company Code	Generator Site Name	Generator Site Code	Facility Identification Number	Unit Contact Information	Technology Type	Facility Noncompetitive Certification Data
El Paso Electric Company	El Paso Electric	EPE	Hueco Mountain Wind Ranch	EPE1	1	Monica Garcia	Wind	23631
FPL Pecos Wind 1 LP, LLC	FPL Pecos Wind I & II, LP	93	WOODWARD1	WOODWRD1	2	Jesse Nevarez	Wind	Unknown
Trent Wind Farm, L.P.	Trent Wind Farm, L.P.	70	TRENT MESA WIND FARM	TRENT	5	Richard Walker	Wind	24322
FPL Energy Upton Wind I, L.P.	FPL Energy Upton Wind I, LP	94	KING MOUNTAIN SW	KING_SW	6	Jesse Nevarez	Wind	Unknown
FPL Energy Upton Wind II, LP	FPL Energy Upton Wind II, LP	96	KING MOUNTAIN NW	KING_NW	7	Jesse Nevarez	Wind	Unknown
FPL Pecos Wind 2 LP, LLC	FPL Energy Pecos Wind I&II, LP	93	WOODWARD 2	WOODWRD2	8	Jesse Nevarez	Wind	24296
Delaware Mountain Wind Farm LP	DELAWARE MOUNTAIN WIND FARM LP	16	DELAWARE MOUNTAIN	DELAWARE	9	Linda Brandi	Wind	23705
Indian Mesa, L.P.	NWP INDIAN MESA WIND FARM LP	17	INDIAN MESA NWP	INDNNWP	10	Linda Brandi	Wind	23745
Upton Wind III, LP	FPL Energy Upton Wind III, LP	96	KING MOUNTAIN NE	KING_NE	14	Jesse Nevarez	Wind	20063
FPL Energy Upton Wind IV, LP	FPL Energy Upton Wind IV, LP	96	KING MOUNTAIN SE	KING_SE	15	Jesse Nevarez	Wind	Unknown
Desert Sky Wind Farm 1 LP	Indian Mesa Power Parners I, L.P.	999	Indian Mesa I Wind Power	INDNENR	16	Richard Walker	Wind	24921
Desert Sky Wind Farm 2 LP	Indian Mesa Power Parners II, L.P.	999	Indian Mesa II Wind Power	INDNENR	17	Richard Walker	Wind	24922
Llano Estacado	Llano Estacado Wind Ranch at White Deer	Shell	White Deer	White Deer Wind	18	Crystal Wuest	Wind	23633
Sweetwater Wind Power LLC	Sweetwater Wind power LLC	1.38E+08	Sweetwater Wind 1	SWEETWND	43	Kim Takayesu	Wind	28924
Brazos Wind, LP	Brazos Wiind LP	Brazos Wind	Green Mountain Energy Wind Farm at Brazos	BRAZ_WND1	44	Scott McBride	Wind	29025
Brazos Wind, LP	Brazos Wind LP	Brazos Wind	Green Mountain Energy Wind Farm at Brazos	BRAZ_WND2	45	Scott McBride	Wind	29025
Aeolus Wind	Aeolus Wind, LLC	Aeolus Wind, LLC	North Texas	NA	51	Bridget Hutchinson	Wind	NA
Sweetwater Wind Power LLC	Sweetwater Wind Power	Sweet Wind 2	Sweetwater Wind 2	SWEETWND2	52	Kim Takayesu	Wind	30462
Callahan Divide	FPL Energy Callahan Divide	30385	Callahan Wind Energy	30385	55	David Gonzalez	Wind	30385
Buffalo Gap Wind Farm LLC	Buffalo Gap Wind Farm, LLC	Buffalo Gap	Buffalo Gap Wind Farm	Buffalo Gap	56	Gabe Vaca	Wind	31412
Horse Hollow	FPL Energy Horse Hollow Wind	0	Horse Hollow Wind Energy	0	57	John Mantyh	Wind	31594
Sweetwater Wind Power LLC	Sweetwater Wind Power	6.04E+08	Sweetwater Wind 3 LLC_AE	SWEETWND3	58	Kim Takayesu	Wind	31983
Sweetwater Wind Power LLC	Sweetwater Wind Power	603943148-3000	Sweetwater Wind 3 LLC_CPS	SWEETWND3	59	Kim Takayesu	Wind	31983
American Wind Power Center	American Wind Power Center	Lubbock	AWPC	AWPC#1	60	Coy F. Harris	Wind	32470
JD Wind 1	JD Wind 1	20137	JD Wind 1	JD Wind 1	65	Steve Maller	Wind	32802
JD Wind 2	JD Wind 2	20138	JD Wind 2	JD Wind 2	66	Steve Maller	Wind	32803
JD Wind 3	JD Wind 3	20139	JD Wind 3	JD Wind 3	67	Steve Maller	Wind	32804
Mesquite Wind, LLC	Mesquite Wind LLC	Horizon Wind	Horizon Wind	Horizon Wind	68	Brian Hayes	Wind	32936

Table 7-5: ERCOT REC Generator List – Wind (cont'd.).

Company Name	Power Generating Company Name	Power Generating Company Code	Generator Site Name	Generator Site Code	Facility Identification Number	Unit Contact Information	Technology Type	Facility Noncompetitive Certification Data
FPL Energy Horse Hollow Wind II, LP	FPL Energy Horse Hollow II, LP	Horse Hollow II	Horse Hollow II	Horse Hollow II	69	John Mantyh	Wind	32524
Post Wind Farm LP	Post Wind Farm, LP	Post Wind	Post Wind	Post Wind	70	John Cote	Wind	32525
JD Wind 5	JD Wind 5	20154	JD Wind 5	JD Wind 5	71	Steven Maller	Wind	32912
JD Wind 6	JD Wind 6	20155	JD Wind 6	JD Wind 6	72	Steven Maller	Wind	32913
Airtricity Forest Creek Wind Farm, LLC	Airtricity Forest Creek Wind Farm, LLC	210	Forest Creek Wind Farm	MCDLD	74	John Franklin	Wind	20166
JD Wind 4	JD Wind 4	20153	JD Wind 4	JD Wind 4	75	Steven Maller	Wind	33760
Airtricity Sand Bluff Wind Farm, LLC	Airtricity Sand Bluff Wind Farm, LLC	211	Sand Bluff Wind Farm	MCDLD	77	Phil Dutton	Wind	20165
Post Oak Wind, LLC	Post Oak Wind	Post Oak Wind	Post Oak Wind	Post Oak Wind	78	Brian Hayes	Wind	33801
Sweetwater Wind Power LLC	Sweetwater Wind 4 LLC	Sweetwater Wind 4 LLC	Sweetwater Wind 4 LLC	Sweetwater Wind 4 LLC	79	Kim Takayesu	Wind	34058
Scurry County Wind, L.P.	Scurry County Wind, L.P.	scurry county wind	Camp Springs Energy Center	CSEC	80	Scott Ebner	Wind	33902
Buffalo Gap Wind Farm 2, LLC	Buffalo Gap Wind Farm 2, LLC	6.04E+08	Buffalo Gap Wind Farm	BUFF_GAP	81	William Barnes	Wind	33477
Sweetwater Wind Power LLC	Sweetwater Wind 5 LLC	Sweetwater Wind 5 LLC	Sweetwater Wind 5 LLC	SWEETWN5	82	Kim Takayesu	Wind	34709
Capricorn Ridge Wind, LLC	Goat Mountain Wind LP	Goat Mountain Wind	Capridge	Capridge	93	Garson Knapp	Wind	34549
Mission Wind LLC	Wildorado Wind, LLC	Mission Wind	Mission Wind	Mission Wind	94	Maria Litos	Wind	32900
Snyder Wind Farm, LLC	Snyder Wind Farm, LLC	20187	Snyder Wind Farm	ENAS	96	Eric Barreveld	Wind	34754
Goat Wind, LP	Goat Wind, LP	8.09E+08	GOAT WIND LP	GOAT WIND	98	Johnny Johnson	Wind	35439
Airtricity Champion Wind Farm, LLC	Airtricity Champion Wind Farm, LLC	242	Champion Wind Farm	TKWSW	99	Audrey Fogarty	Wind	20182
Airtricity Roscoe Wind Farm, LLC	Airtricity Roscoe Wind Farm, LLC	243	Roscoe Wind Farm	TKWSW1	100	Audrey Fogarty	Wind	20180
Scurry County Wind II LLC	Scurry County Wind II LLC	scurry county wind II	Camp Springs Energy Center	CSEC	101	Scott Ebner	Wind	35290
Stanton Wind Energy LLC	Stanton Wind Energy LLC	stanton wind	Stanton Wind Energy LLC	SWEC	102	Scott Ebner	Wind	35206
Whirlwind Energy, LLC	Whirlwind Energy, LLC	WELLC	Whirlwind Energy Center	WEC	103	Matthew Burt	Wind	20172
JD Wind 9 LLC	JD Wind 9	20189	JD Wind 9	JD Wind 9	104	Steve Maller	Wind	34924
JD Wind 8 LLC	JD Wind 8	20194	JD Wind 8	JD Wind 8	105	Steven Maller	Wind	34991
JD Wind 10 LLC	JD Wind 10	20195	JD Wind 10	JD Wind 10	106	Steven Maller	Wind	34992
JD Wind 11 LLC	JD Wind 11	20196	JD Wind 11	JD Wind 11	107	Steven Maller	Wind	34993
JD Wind 7 LLC	JD Wind 7	20193	JD Wind 7	JD Wind 7	108	Steven Maller	Wind	34990
Buffalo Gap Wind Farm 3, LLC	Buffalo Gap Wind Farm 3, LLC	Buffalo Gap Wind Farm 3, LLC	Buffalo Gap Wind Farm	BUFF_GAP	110	Fang Qing	Wind	35247
High Plains Wnd Power LLC	High Plains Wind Power LLC	20197	High Plains Wind Power	High Plains Wind Power	111	Steven Maller	Wind	34994

Table 7-6: Electricity Generation by Renewable Sources (MWh, ERCOT: 2001 – 2007 by Quarter).

Technology Type	Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total MWh
Biomass	2001					
Hydro	2001					
Landfill gas	2001					
Solar	2001	0	0	11293	19346	30639
Wind	2001	0	0	201,118	364,479	565,597
Totals		0	0	212,411	383,825	596,236

Technology Type	Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total MWh
Biomass	2002					
Hydro	2002	105,817	69,165	80,154	56,956	312,093
Landfill gas	2002	8,216	7,073	6,986	7,137	29,412
Solar	2002	0	29	37	21	87
Wind	2002	611,708	716,896	622,262	500,618	2,451,484
Totals		725,741	793,163	709,439	564,732	2,793,076

Technology Type	Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total MWh
Biomass	2003	8,876	11,253	10,999	8,368	39,496
Hydro	2003	92,680	52,592	71,699	22,713	239,684
Landfill gas	2003	29,995	44,629	39,920	39,662	154,206
Solar	2003	32	70	69	49	220
Wind	2003	561,994	670,248	617,794	665,446	2,515,482
Totals		693,577	778,792	740,481	736,238	2,949,088

Technology Type	Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total MWh
Biomass	2004	6,274	11,459	11,482	7,725	36,940
Hydro	2004	55,638	52,735	52,350	74,067	234,791
Landfill gas	2004	52,801	47,964	53,659	49,018	203,443
Solar	2004	31	67	70	44	211
Wind	2004	815,010	1,014,396	610,157	770,066	3,209,629
Totals		929,755	1,126,621	727,718	900,920	3,685,014

Table 7-6: Electricity Generation by Renewable Sources (MWh, ERCOT: 2001 – 2007 by Quarter) – (cont'd.).

Technology Type	Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total MWh
Biomass	2005	13,921	15,069	14,764	14,883	58,637
Hydro	2005	108,974	106,893	61,189	33,246	310,302
Landfill gas	2005	52,118	51,193	56,166	54,301	213,777
Solar	2005	46	69	67	46	227
Wind	2005	801,232	1,246,182	869,508	1,304,646	4,221,568
Totals		976,291	1,419,406	1,001,694	1,407,122	4,804,511

Technology Type	Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total MWh
Biomass	2006	16,327	10,479	17,152	16,610	60,569
Hydro	2006	55,000	83,064	44,870	27,143	210,077
Landfill gas	2006	69,191	78,650	75,665	82,580	306,087
Solar	2006	26	43	41	26	136
Wind	2006	1,478,927	1,584,166	1,376,540	2,091,295	6,530,928
Totals		1,619,471	1,756,402	1,514,268	2,217,654	7,107,797

Technology Type	Year	Quarter 1	Quarter 2	Quarter 3	Quarter 4	Total MWh
Biomass	2007	13,052	15,061	11,991	11,720	51,823
Hydro	2007	66,084	120,486	139,965	56,346	382,882
Landfill gas	2007	84,367	86,372	85,612	99,987	356,339
Solar	2007	339.1	502.73	541.03	461.03	1843.89
Wind	2007	1,961,152	2,029,806	2,020,869	3,327,929	9,339,756
Totals		2,124,994	2,252,228	2,258,979	3,496,444	10,132,645

Table 7-7: Electricity Generation by Renewable Sources (MWh, ERCOT: 2001 – 2007 by Quarter).

Technology Type	2001	2002	2003	2004	2005	2006	2007
Wind	565597	2,451,484	2,515,482	3,209,629	4,221,568	6,530,928	9,339,756
Hydro		312,093	239,684	234,791	310,302	210,077	382,882
Landfill gas		29,412	154,206	203,443	213,777	306,087	356,339
Biomass			39496	36940	58637	60569	51823.39
Solar	30639	87	220	211	227	136	1,844
Totals	596236	2,793,076	2,949,088	3,685,014	4,804,511	7,107,797	10,132,645

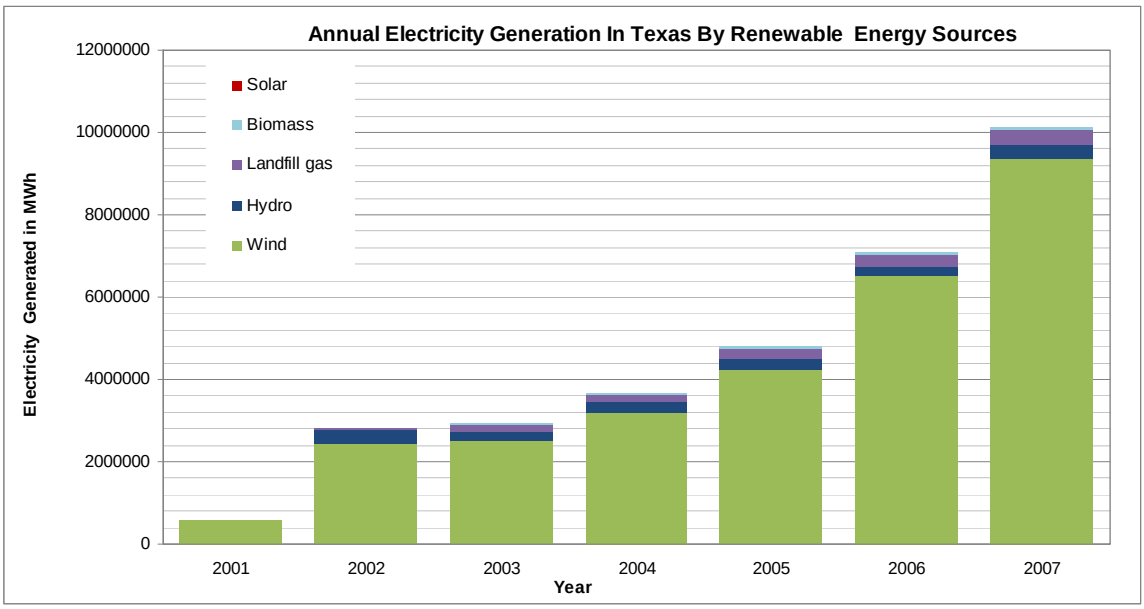


Figure 7-1: Electricity Generation by Renewable Sources (ERCOT: 2001 – 2007 Annual).

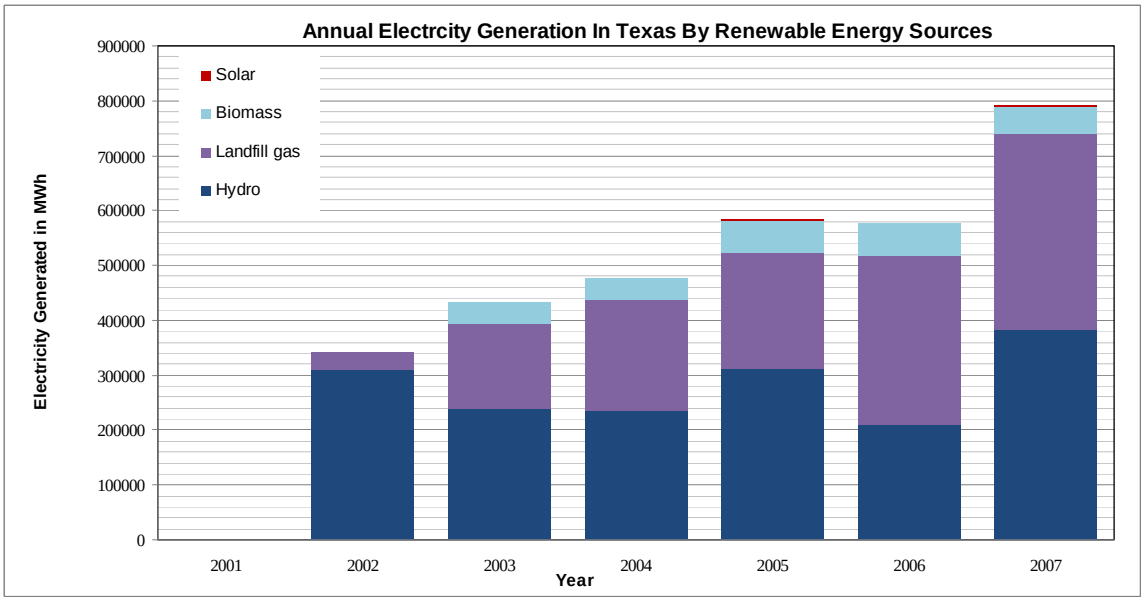


Figure 7-2: Electricity Generation by Renewable Sources Other Than Wind (ERCOT: 2001 – 2007 Annual).

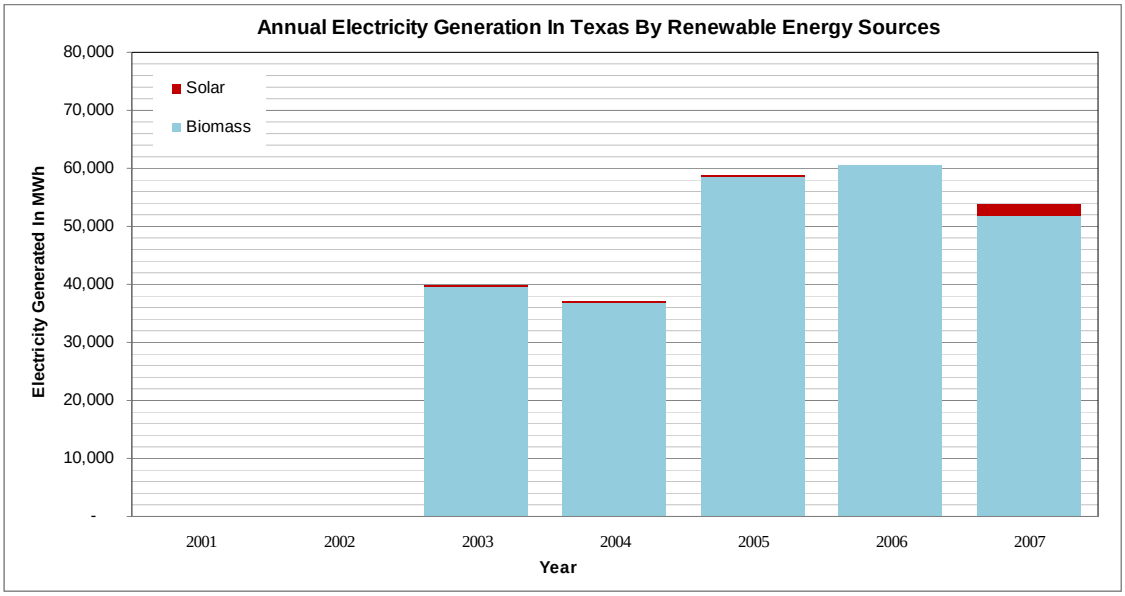


Figure 7-3: Electricity Generation by Renewable Sources from Solar and Biomass (ERCOT: 2001 – 2007 Annual).

7.3 Future Wind Development Issues

Wind farm development in Texas will still be driven by the production tax credit, date of the extension, and availability of transmission capacity[8]. The installed capacity in Texas is projected to be over 11,000 MW by 2010 and could easily reach 22,000 MW by 2015. One of the major problems is that most of the windy land is not close to the major load centers. Another part of the problem is that the Texas Panhandle is not a part of ERCOT. Due to the inadequate transmission infrastructure to accommodate existing wind farms in west Texas, the electric transmission system needs to be upgraded in ERCOT. As requested by the PUCT, ERCOT conducted an optimization study of the transmission plans, which is known as Competitive Renewable Energy Zones (CREZ). The CREZ was selected based on areas of the state with the highest wind potential and the transmission of wind power to the load centers in ERCOT (ERCOT 2006). Eight zones were selected and ultimately combined into five zones (Figure 7-4) from the original 24 potential zones (Dan Woodfin 2008). Different transmission scenarios (Table 7-8 and Table 7-9) have been proposed which include the construction of transmission loops in the Panhandle for power to ERCOT (Figure 7-5). Figure 7-6 illustrates the action plan from the PUCT regarding the CREZ[9].

[8] Reference: a report from Frontier Associates on renewable energy.
[9] Information obtained from a presentation by Henry Durrwachter, "Development of Wind in Texas," July 8, 2008.

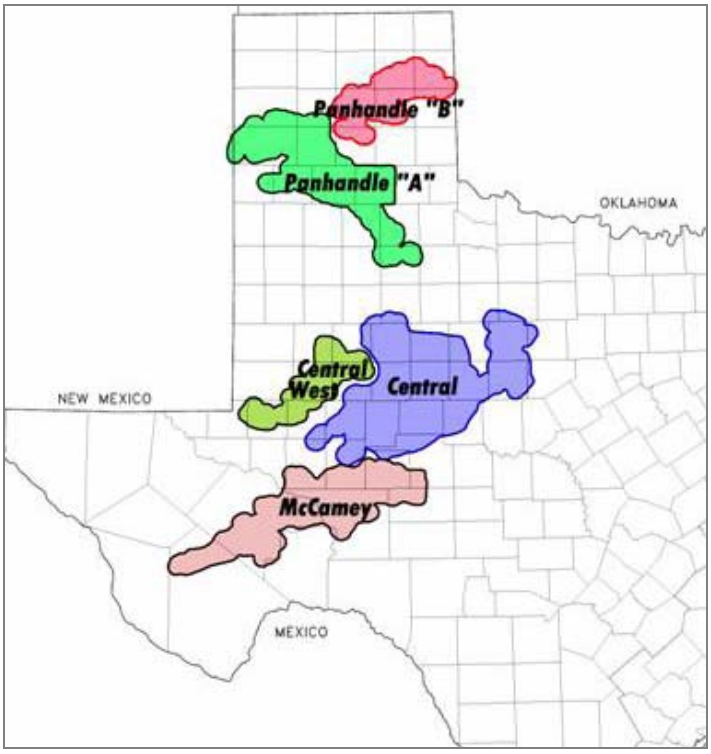


Figure 7-4: Competitive Renewable Energy Zones Selected by ERCOT.

Table 7-8: Capacity (MW) of the New CREZ Wind by Scenario.

Wind Zone	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Panhandle A	1,442	3,191	4,960	6,660
Panhandle B	1,067	2,293	3,270	0
McCamey	829	1,859	2,890	3,190
Central	1,358	3,047	4,735	5.615
Central West	474	1.063	1,651	2,051
Total*	12,053	18,456	24,859	24,419

Table 7-9: Estimated Cost Summary and Miles of Transmission Lines for the CREZ Scenarios.

Scenario	Wind Installed Installed MW	Transmission Cost $B	Collection Cost $B	Total New ROW miles
1A	12053	3	9.35-0.41	1,638
1B	12,053	4	0.41-0.53	1831
2	18456	4.93	0.58-0.82	2,376
3	24,859	6	0.72-1.03	3,036
4	24419	5.75	0.67-0.94	2489

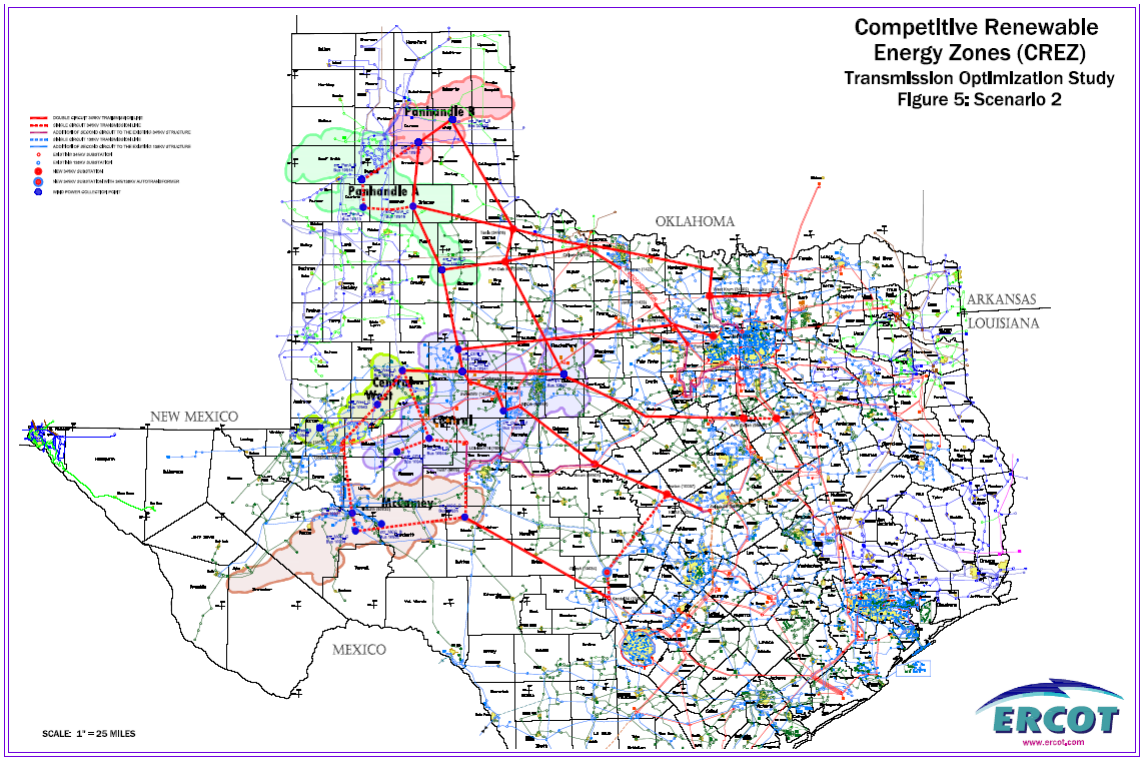


Figure 7-5: Scenario 2 for Transmission Lines for CREZ.

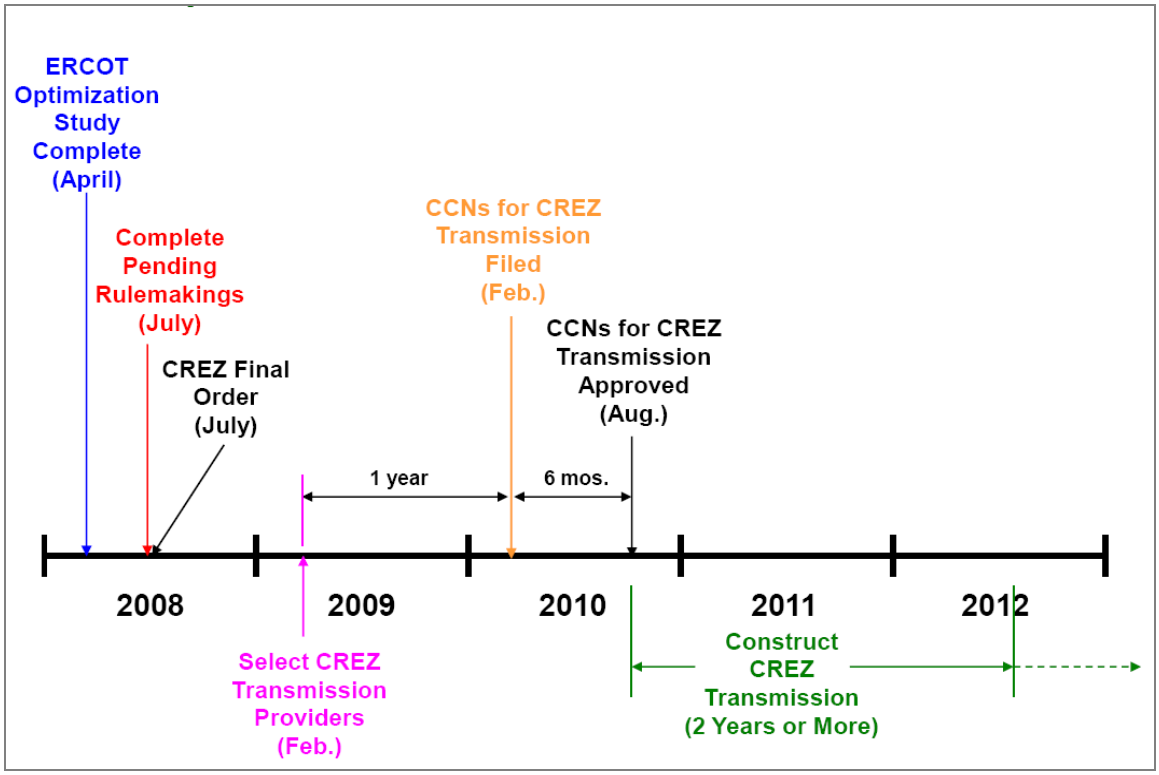


Figure 7-6: The PUCT's Action Plan on CREZ.

8 COMBINED HEAT AND POWER PROJECTS IN TEXAS

Texas leads the US in Combined Heat and Power (CHP) applications, which is known as cogeneration. About 23% of all CHP generation capacity in the US is located in Texas[10]. This capacity produces 20% of the electricity in Texas[11], as shown in Figure 8-1[12]. Typical power plants built by electric utilities in Texas are steam plants that are 25% - 35% efficient. The natural gas combined cycle power plants operate at about 50% efficiency. CHP technologies generate electrical and thermal energy in a single, integrated system close to the point of customer energy demand. A typical CHP system consists of a prime mover to generate electricity, a heat recovery system to capture heat, a control system, an exhaust system, and an acoustic enclosure. The thermal energy recovered in a CHP system can be used for heating or cooling in industry or buildings. Thus, CHP facilities are a major energy conservation technique with a high efficiency falling to the 70% - 85% range.

As of 2005, 16,659 MW of CHP technologies were integrated into infrastructure served by the Texas electrical grid. Table 8-1 summarizes all of the CHP projects that began operation from 1921 to 2005 in Texas[13], including the operation year, capacity, city located, type of prime mover, type of primary fuel, and utility connected, etc., for each CHP project.

CHP systems can reduce NOx emissions at the host site where they are located and at the utility power plants that would otherwise generate electricity for host facilities. The integration of a CHP plant into an electrical power system reduces NOx in the following ways (Gulf Coast CHP Regional Application Center, 2008):

- CHP reduces the use of conventional boilers.
- CHP allows some electrical loads for heating water or providing thermal conditioning of space to be served directly with the thermal energy that was previously discharged to the environment.
- Replacement of grid power with CHP electricity reduces NOx at the utility power plant, because electricity generated from CHP produces much less NOx emissions than do most utility power plants.
- CHP eliminates losses from the transmission and distribution of electricity otherwise produced by central stations and delivered through the grid.

However, calculating emissions reduction encounters the following major complications. First, it is difficult to access all the necessary information and data from the individual CHP system for the calculation and reporting purpose. Second, some of the CHP were included in the eGRID while others are not. A careful examination of eGRID and CHP plants is needed. Third, development of CHP at facilities in the city would relocate the source of NOx emissions from large point sources outside the city to many small point sources inside the city. Therefore, the geographical impact on NOx emissions should be considered. Fourth, incorporation of an air dispersion model to consider effect of exhaust stack heights or wind speeds to determine local NOx concentrations requires more investigation and research. In addition, the complex chemistry of ozone formation and transportation would also impact the calculation methodology.

The ESL is working on developing a procedure to estimate the emissions reduction from CHP applications. The results will be included in the future report when it is ready.

[10] USDOE, Energy Information Agency (EIA), 2005 data.
[11] USDOE, Energy Information Agency (EIA), 2006 data
[12] Plot obtained from Texas CHP Initiative website: http://www.texaschpi.org/content/future/future.asp
[13] Information obtained from the website of Gulf Coast CHP Application Center.
http://files.harc.edu/Sites/GulfCoastCHP/GulfCoastCHPDatabase.xls

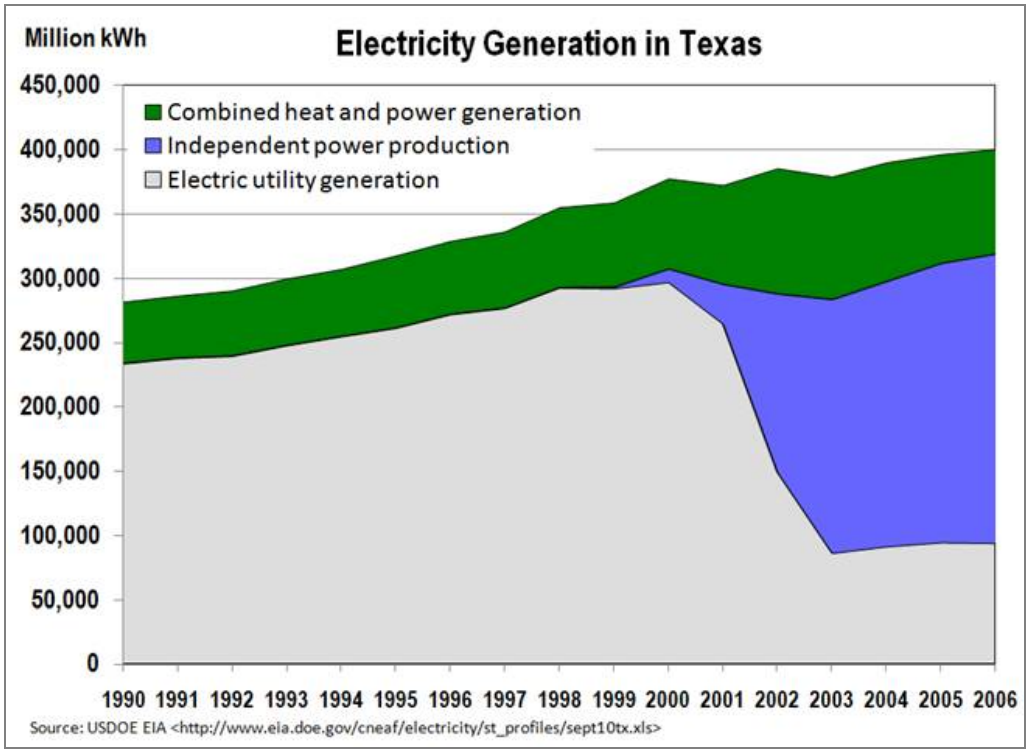


Figure 8-1: Electricity Generation in Texas in 2006.

Table 8-1: CHP Projects in Texas as of 2005.

Operator Name	Facility Name	City	State	Op Year	SIC4/NAICS	Capacity (kW)	Prime Mover	Prim. Fuel	Utility Name	Sales to Util
South Houston Green Power LP / Green Power 2 / Cinergy	BP Texas City Refinery	Texas City	TX	2004	2911	570,000	CT	NG	Texas-New Mexico Power Co	Y
Austin Energy	Domain Industrial Park	Austin	TX	2004	3999	4,500	CT	NG	Austin Energy	
Calpine - Deer Park Energy Center	Shell Chemical Company	Deer Park	TX	2003	2911	792,000	CC	NG	Reliant Energy HL&P	
Calpine - Corpus Christi Energy Center	Citgo Refining	Corpus Christi	TX	2002	2911	523,000	CC	NG	Central Power & Light Co	Y
Rebekah Baines Johnson Health Center	Rebekah Baines Johnson Health Center	Austin	TX	2002	7997	200	FCEL	NG	Austin Energy	Y
Calpine - Central LP	Baytown Energy Center LP	Addis	TX	2002	2911	914,000	CC	NG	Reliant Energy HL&P	
BASF Corp	NROC Cogeneration Facility	Port Arthur	TX	2001	2899	83,200	CT	NG	Entergy Gulf States Inc	N
Eastex CoGeneration LP	Eastex Cogeneration Facility	Longview	TX	2001	2800	467,700	CT	NG	Southwestern Electric Coop Inc	N
Reliant Energy Power Ops I Inc	Reliant Energy Channelview LP	Channelview	TX	2001	2800	293,000	CT	NG	Reliant Energy HL&P	N
SRW Cogeneration LP	SRW Cogeneration Limited Partnership	Orange	TX	2001	2800	360,000	CT	NG	Entergy Gulf States Inc	N
BP Amoco Chemicals Company	BP Solvay Polyethylene North America	Deer Park	TX	2001	2911	20,000	CT	OTR		
Calpine - Channel Energy Center	Channel Energy Center	Harrison	TX	2001	2911	215,000	CT	NG	Reliant Energy Channelview LP	
LSP-Pike Energy LLC	Port Arthur	Jefferson	TX	2001	4939	82,400	CT	NG	Entergy Gulf States Inc	
Calpine - Pasadena	Pasadena Ii-Expansion Of Pasadena I	Pasadena	TX	2000	2800	751,000	CC	NG	Reliant Energy Hl&P	Y
E.I. Du Pont De Nemours & Company	Du Pont Sabine River Works	Orange	TX	2000	2800	220,000	CC	NG	Entergy Gulf States Inc	Y
Lg&E Power Inc./Gregory Power Partners	Reynolds Metals Sherwin Alumina Plant	Gregory	TX	2000	2819	400,000	CC	NG	Central Power & Light Co	Y
BASF / Fina Petrochemicals LP	Steam Cracker Cogen Project	Port Arthur	TX	2000	2911	70,900	CT	NG	Z-Local	N
Leviton Manufacturing Inc	Leviton Manufacturing Co	El Paso	TX	2000	9900	1,800	RENG	OIL	El Paso Electric Co	N
Premcor Refining Group / Air Products And Chemicals, Inc.	Clark Refining & Marketing	Port Arthur	TX	2000	2911	40,000	CC	NG	Entergy Gulf States Inc	N
Enichem Americas, Inc.	Enichem Americas	Baytown	TX	2000	2800	5,300	CT	NG		
BASF Corp	Freeport Project	Freeport	TX	1999	2819	81,000	CC	NG	Reliant Energy Hl&P	Y
Borger Energy Associates LP	Black Hawk Station	Borger	TX	1999	2869	253,800	CT	NG	Southwestern Public Service Co	Y
Goodyear Tire & Rubber Company	Beaumont/East Chemical Plant	Beaumont	TX	1999	2822	18,835	CC	NG	Entergy Gulf States Inc	Y
Occidental Energy Ventures & Conoco Global Power	Ingleside Cogeneration Facility	Gregory/Ingleside	TX	1999	2869	440,000	CC	NG	Central Power & Light Co	Y
Freeport Mcmoran	Freeport Mcmoran	Pecos	TX	1999	2911	5,200	CT	NG		N
Sweeny Cogeneration LP	Phillips Sweeny Complex	Sweeny (Near)	TX	1998	2911	358,000	CT	NG	Texas-New Mexico Power Co	Y
Lackland AFB Hospital	Lackland AFB Hospital	San Antonio	TX	1998	8062	10,400	CT	NG		N
Gas Recovery Systems Inc	Sunset Farms	Austin	TX	1996	4953	3,030	RENG	BIOMASS	Austin City Of	Y
Tenaska Iv Texas Partners Ltd.	Steam Host Is Distilled Water	Cleburne	TX	1996	2899	258,000	CC	NG	Brazos Electric Power Coop Inc	Y
Union Carbide Corporation	Union Carbide Chemicals & Plastics Co	Texas City	TX	1996	2821	84,500	CC	NG	Texas-New Mexico Power Co	Y
R.E. Thomason Hospital	Thomason Hospital Central Plant	El Paso	TX	1996	8062	2,400	RENG	NG		N
Houston Lighting & Power	Dupont Cogeneration Project	La Porte/Deer Park	TX	1995	2869	162,000	CC	NG		Y
Shell Oil Company	Shell Manufacturing Complex	Deer Park	TX	1995	2911	250,000	CC	NG	Reliant Energy Hl&P	Y
Dow Chemical U.S.A. - Texas Division	Oyster Creek Project	Freeport	TX	1994	2819	424,000	CC	NG	Reliant Energy Hl&P	Y
Big Three Industries, Inc.	Air Separation Plant	Port Neches	TX	1993	2813	41,200	CT	NG	Entergy Gulf States Inc	Y
Dallas County	Lew Sterrett/North Tower Cogen Facility	Dallas	TX	1993	9111	1,000	CT	NG		N
Huntsman Petrochemicals	Port Neches Chemical Plant	Port Neches	TX	1993	2819	71,260	CT	NG	Entergy Gulf States Inc	N
Solutia, Inc.	Chocolate Bayou Plant	Alvin	TX	1993	2899	55,300	B/ST	NG	Reliant Energy Hl&P	N
Kimmon Quartz Ltd.	Fossil Creek Project	Fort Worth	TX	1992	3211	550	RENG	NG		Y
Phillips 66 Company	Sweeny Refinery	Old Ocean	TX	1992	2911	760	Z-NA	OTR		Y
Phelps Dodge Corporation	Phase II Cogeneration Facility	El Paso	TX	1992	3331	16,843	CT	NG	El Paso Electric Co	N
Union Carbide Industrial Gases Inc.	Linde Division/Sterling Chemicals Inc.	Texas City	TX	1992	2813	52,000	CC	NG	Texas-New Mexico Power Co	N
Union Oil Company Of California/Unocal	North Riley Unit	Seminole (Near)	TX	1992	2911	2,870	RENG	NG	Southwestern Public Service Co	N
Formosa Plastics Corporation, Usa	Point Comfort Project	Point Comfort	TX	1991	2821	537,400	CC	NG	Central Power & Light Co	Y
Hill Petroleum Company	Hill Petroleum Company	Texas City	TX	1991	2911	38,120	CT	NG	Texas-New Mexico Power Co	Y
Valero Refing Co. / Hill Petroleum Company	Hill Petroleum Refinery	Houston	TX	1990	2911	34,240	CC	NG	Reliant Energy Hl&P	Y
American Private Power, Inc.	310 Padre Boulevard	South Padre Island	TX	1990	7011	240	RENG	OIL	Local	N
E.I. Du Pont De Nemours & Company	Beaumont Petrochemical Plant	Beaumont	TX	1990	2822	33,800	CT	NG	Gulf States Utilities	N
ICC Technologies, Inc.	Aire-Technics, Inc.	Houston	TX	1990	3569	150	RENG	NG		N

Table 8-1: CHP Projects in Texas as of 2005 (cont'd.).

Operator Name	Facility Name	City	State	Op Year	SIC4/NAICS	Capacity (kW)	Prime Mover	Prim. Fuel	Utility Name	Sales to Util
Texas Department Of Mental Health	Austin State Hospital	Austin	TX	1990	8062	2,200	CT	NG	Austin City Of	N
Texas Tech University	Texas Tech University	Lubock	TX	1990	8221	935	B/ST	NG		N
City of Lubbock	Brandon	Lubbock	TX	1990	4939	21,000	CT	NG		
Ccpc Chemical, Inc. / Occidental	CCPC Chemical, Inc.	Corpus Christi	TX	1989	2824	37,880	CT	NG		Y
Encogen One Partners, Ltd.	United States Gypsum Company	Sweetwater	TX	1989	3275	255,000	CC	NG	Txu Electric Co	Y
Equistar Chemicals LP	Corpus Christi Plant	Corpus Christi	TX	1989	2911	45,176	CT	NG	Central Power & Light Co	Y
Hoechst Celanese Corporation	Hoechst Celanese Corporation	Bishop	TX	1989	2823	45,000	CC	NG	Central Power & Light Co	Y
Rice University	Rice University Power Plant	Houston	TX	1989	8221	7,000	CC	NG	Reliant Energy HI&P	Y
Tenaska III Texas Partners	Campbell Soup (Texas), Inc.	Paris	TX	1989	2032	223,000	CC	NG	Txu Electric Co	Y
Exxon Chemical Company Nqtx-511 1 Of 2	Exxon Baytown Olefins Plant	Baytown	TX	1989	2911	279,500	CT	NG	Reliant Energy HI&P	N
Southwest Texas State University	Southwest Texas State University	San Marcos	TX	1989	8221	6,025	RENG	NG	San Marcos City Of	N
Alcon Laboratories, Inc.	Alcon Laboratories, Inc.	Fort Worth	TX	1988	3300	3,500	CT	NG		Y
Chevron U.S.A., Inc.	Warren Petroleum Company	Mont Belvieu	TX	1988	1311	10,000	CT	NG	Houston Lighting & Power	Y
Fina Oil & Chemical Company	Fina Oil & Chemical Company	Port Arthur	TX	1988	2911	37,130	CC	NG	Entergy Gulf States Inc	Y
Koch Refining Company	Koch Refining Company	Corpus Christi	TX	1988	2911	49,000	CT	NG	Carolina Power & Light Co	Y
American Private Power, Inc.	Sheraton Hotel, 2211 I35 East North	Denton	TX	1988	7011	115	RENG	NG	Local	N
Baylor University	Baylor University	Waco	TX	1988	8221	3,300	CT	NG	Txu Electric Co	N
BP Amoco Chemicals Company	Wasson Field Cogeneration Facility (II)	Denver City	TX	1988	2813	20,660	CT	NG	Southwestern Public Service Co	N
Minnesota Mining & Manufacturing Co./ 3M	3M Res., Dev., & Admin. Center	Austin	TX	1988	6512	14,300	RENG	NG	Austin City Of	N
Shell Oil Company	Westhollow Technology Center	Houston	TX	1988	1311	3,725	CT	NG	Reliant Energy HI&P	N
E.I. Du Pont De Nemours & Company	Du Pont Nylon/Polyethyelene Plant	Victoria	TX	1987	2821	75,000	CT	NG	Central Power & Light Co	Y
Power Resources, Inc.	Fina Oil & Chemical/American Petrofina	Big Springs	TX	1987	2911	200,000	CC	NG	Txu Electric Co	Y
Seadrift Cogeneration	Union Carbide Corporation	Seadrift	TX	1987	2813	110,000	CC	NG	Central Power & Light Co	Y
Texas City Cogeneration.	Union Carbide - Texas City Plant	Texas City	TX	1987	2869	450,000	CC	NG	Texas New Mexico Power Co	Y
Wichita Falls Energy Company	Vetrotex/Certainteed Corporation	Wichita Falls	TX	1987	3229	80,000	CC	NG	Texas Utilities Electric	Y
Air Products & Chemicals, Inc.	Air Products Manufacturing Corp	Pasadena	TX	1987	2816	3,460	CT	NG	Reliant Energy HI&P	N
Gabriel Mills Energy Company	Greenhouse Project	Liberty Hill	TX	1987	182	2,000	RENG	NG		N
Tenet Hospital Ltd	Providence Memorial Hospital	El Paso	TX	1987	8062	4,200	RENG	NG	El Paso Electric Co	N
AES Corporation	AES Deepwater Inc	Pasadena	TX	1986	2869	143,000	B/ST	WAST	Reliant Energy HI&P	Y
BP Amoco Chemicals Company	Texas City Refinery Facilitiy	Texas City	TX	1986	2911	250,000	CC	WAST	Texas-New Mexico Power Co	Y
Hospital Corporation Of America/Thermo	Vista Hills Medical Center	El Paso	TX	1986	8062	180	RENG	NG	El Paso Electric Company	Y
Sid Richardson Carbon & Gas Company	Sid Richardson Carbon & Gas Company	Borger	TX	1986	2895	30,000	B/ST	WAST	Southwestern Public Service Co	Y
Uncle Ben's, Inc.	Uncle Ben's Rice	Houston	TX	1986	2044	1,000	B/ST	BIOMASS	Houston Lighting & Power	Y
B&D Cogen Funding Management	Occidental / Diamond Shamrock Chemnical	Deer Park	TX	1986	2812	95,000	CC	NG	Reliant Energy HI&P	N
Bruce Foods Corporation	Ashley's Division	El Paso	TX	1986	2033	220	RENG	NG	El Paso Electric	N
Enterprise Products Company	Enterprise Products Company	Mt. Belvieu	TX	1986	2911	26,090	CT	NG	Reliant Energy HI&P	N
Fina Oil & Chemical Company	Big Spring Texas Refinery	Big Spring	TX	1986	2911	1,500	B/ST	NG	Txu Electric Co	N
Marathon	Marathon	Yates	TX	1986	2911	7,030	CT	NG	West Texas Utilities Co	N
Westvaco / Temple-Inland Forest Products Corporation	Evandale Pulp & Paperboard	Evadale	TX	1986	2631	48,200	B/ST	WAST	Entergy Gulf States Inc	N
Bayou Cogeneration Enron/Dominion	Bayport Industrial Complex/Big Three Ind	Bayport	TX	1985	2800	300,528	CC	NG	Houston Lighting & Power	Y
BP Amoco Chemicals Company	Chocolate Bayou Facility	Alvin	TX	1985	2911	36,300	CT	NG	Reliant Energy HI&P	Y
Cogen Lyondell, Inc.	Arco Chemicals/Lyondell Petrochemical	Channelview/Houston	TX	1985	2911	590,000	CC	NG	Reliant Energy HI&P	Y
South Houston Green Power / BP-Amoco Oil Company	Amoco Oil Company/Power 4	Texas City	TX	1985	2911	170,000	CC	NG	Texas New Mexico Power Co	Y
Dean Lumber Company	Dean Lumber Company	Gilmer	TX	1985	2421	540	B/ST	WOOD	Southwestern Electric Power	N
Air Liquide America Corp	Bayou Cogeneration Plant	Pasadena	TX	1984	2813	300,000	CT	NG	Reliant Energy HI&P	Y
Clear Lake Cogeneration L.P.	Hoechst Celanese Chemical Company	Pasadena	TX	1984	2821	377,000	CC	NG	Reliant Energy HI&P	Y
Coastal Refining & Marketing	Coastal Refining & Marketing Inc	Corpus Christi	TX	1984	2911	46,800	CT	NG	Central Power & Light Co	Y
Rhone-Poulenc, Inc.	Stauffer Chemical Company	Manchester	TX	1984	2834	6,500	B/ST	OTR	Houston Lighting & Power	Y
BP Amoco Chemicals Company	Mallet Cogeneration Facility	Sundown	TX	1984	1311	18,000	CT	NG		N

Table 8-1: CHP Projects in Texas as of 2005 (cont'd.).

Operator Name	Facility Name	City	State	Op Year	SIC4/NAICS	Capacity (kW)	Prime Mover	Prim. Fuel	Utility Name	Sales to Util
Crown Central Petroleum Corporation	Crown Central Petroleum Corporation	Pasadena	TX	1984	2911	6,000	B/ST	WAST	Local	N
Imperial Holly Corporation	Imperial Sugar Company	Sugarland	TX	1984	2062	6,000	B/ST	NG	Reliant Energy HI&P	N
Airco Carbon	Airco Carbon	North Seadrift	TX	1983	2999	7,000	B/ST	WAST	Central Power & Light	Y
Carbide/Graphite Group Inc	Seadrift Coke LP	Port Lavaca	TX	1983	2911	7,600	B/ST	WAST	Central Power & Light Co	Y
Cogen Power Company, Inc.	Great Lakes Carbon Corporation/Chevron	Port Arthur	TX	1983	2911	5,000	B/ST	WAST	Gulf States Utilities	Y
Dow Chemical U.S.A. - Texas Division	Energy Systems And Technical Services	Freeport	TX	1983	2819	1,320,000	CC	NG	Reliant Energy HI&P	Y
Engineered Carbons, Inc.	Engineered Carbons Division	Borger	TX	1983	2895	20,000	B/ST	WAST		Y
Valero Refining Company	Saber Refining	Corpus Christi	TX	1983	2911	67,700	B/ST	WAST	Central Power & Light Co	Y
Owl Energy Resources Inc	Houston Chemical Complex Battleground Site	Deer Park	TX	1982	2810	200,000	CC	NG	Reliant Energy HI&P	Y
Texas Petrochemicals Corp	Texas Petrochemicals Houston Plant	Houston	TX	1982	2911	35,000	B/ST	NG	Reliant Energy HI&P	Y
BP Amoco Chemicals Company	BP Chemicals Green Lake Plant	Port Lavaca	TX	1981	2911	32,000	B/ST	OTR	Central Power & Light	Y
ExxonMobil Corp	Exxon Baytown Refinery	Baytown	TX	1980	2911	200,000	CT	NG	Reliant Energy HI&P	N
University Of Texas System	Univerity Of Texas At Dallas	Richardson	TX	1980	8221	3,500	RENG	NG	Txu Electric Co	N
University Of Texas System	University Of Texas At San Antonio	San Antonio	TX	1980	8221	3,500	RENG	NG	San Antonio Public Service Bd	N
Hoechst Celanese Corporation	Celanese Pampa Plant	Pampa	TX	1979	2821	30,000	B/ST	COAL	Southwestern Public Service	N
International Paper Company	Texarkana Mill	Texarkana	TX	1978	2621	65,000	B/ST	WAST	Southwestern Electric Power Co	Y
ExxonMobil Oil Corporation	Mobil Beaumont Refinery	Beaumont	TX	1978	2911	255,000	B/ST	WAST	Entergy Gulf States Inc	N
Lone Star Energy/Enserch/TXU	Univ. Of Texas Health Science Center	Dallas	TX	1978	8221	4,600	RENG	NG		N
Chevron U.S.A., Inc.	Chevron'S Port Arthur Refinery	Port Arthur	TX	1975	2911	62,000	CC	WAST	Entergy Gulf States Inc	Y
Rio Grande Valley Sugar Growers	Rio Grande Valley Sugar Growers	Santa Rosa	TX	1973	2061	5,000	B/ST	BIOMASS	Central Power & Light Co	N
Rhone-Poulenc Inc.	Houston Facility	Houston	TX	1970	2834	6,500	B/ST	NG	Reliant Energy HI&P	Y
Champion International Corporation	Sheldon Mill	Sheldon	TX	1967	2621	95,000	CT	NG	Reliant Energy HI&P	N
Inland-Orange, Inc.	Orange Pulp & Paper Mill	Orange	TX	1967	2652	49,000	B/ST	WAST	Entergy Gulf States Inc	N
ExxonMobil Corp	Power Plant 3	Jefferson	TX	1966	2911	75,000	B/ST	NG	Entergy	
Holly Sugar Corporation	Holly Sugar Corporation	Hereford	TX	1965	2063	4,100	B/ST	NG		N
Arco Oil & Gas Company	Taft Gasoline Plant	Taft	TX	1964	2911	1,400	CT	NG		Y
Rock Tenn Company	Rock Tenn Company	Dallas	TX	1959	2631	4,000	B/ST	NG	Dallas Town Of Texas Electric	N
ExxonMobil Corp	Power Plant 2	Jefferson	TX	1959	2911	122,200	B/ST	NG	Entergy	
Alcoa World Alumina LLC	Pt Comfort Operations	Pt Comfort	TX	1958	2819	63,100	B/ST	NG	Central Power & Light Co	N
Liquid Energy	Liquid Energy	Bridgeport	TX	1958	2911	1,520	RENG	NG		N
Reynolds Metals Co	Reynolds Metals Co Sherwin Plant	Corpus Chritsi	TX	1953	3341	39,000	B/ST	NG	Central Power & Light Co	N
American Chrome & Chemicals Co	American Chrome & Chemicals Co	Corpus Christi	TX	1952	2819	610	B/ST	NG	Local	N
Morton Salt Company	Morton Salt Company	Grand Saline	TX	1949	2899	3,990	B/ST	NG	Southwestern Electric Power Co	N
Snider Industries, Inc	Snider Industries Inc	Marshall	TX	1948	2421	7,500	B/ST	WOOD	Southwestern Electric Power Co	Y
Champion International Corporation	Lufkin Mill	Lufkin	TX	1940	2621	72,000	B/ST	NG	Txu Electric Co	N
Star Enterprise	Texaco Refining And Marketing Inc.	Port Arthur	TX	1939	2911	163,850	CC	WAST	Entergy Gulf States Inc	Y
Texas A&M University	Cogeneration Facility	College Station	TX	1935	8221	37,500	CT	NG		N
University Of Texas At Austin	University Of Texas At Austin	Austin	TX	1932	8221	88,000	CC	NG	Austin City Of	N
Norit Americas Inc	Norit Americas Inc Marshall Plant	Marshall	TX	1921	2810	2,000	B/ST	COAL	Southwestern Electric Power Co	N
Total						16,659,062				

9 REPORTING OF NOX EMISSIONS CREDITS TO THE TCEQ (PRELIMINARY)

9.1 Introduction

In January 2005, the Energy Systems Laboratory was asked by the TCEQ to develop a method by which the NOx emissions savings from the energy-efficiency programs from multiple Texas State Agencies working under Senate Bill 5 and Senate Bill 7 could be reported in a uniform format to allow the TCEQ to consider the combined savings for Texas' State Implementation Plan planning purposes. This required that the analysis should include the cumulative savings estimates from all projects projected through 2020 for both the annual and Ozone Season Day NOx reductions. The NOx emissions reduction from all these programs were calculated using estimated emissions factors for 2007 from the USEPA's eGRID database, which had been specially prepared for this purpose. The different programs included in the 2006 cumulative analysis are:

- ESL Single-family new construction
- ESL Multi-family new construction
- ESL Commercial new construction
- Federal Buildings
- Furnace Pilot Light Program
- PUCT Senate Bill 7 and Senate Bill 5 Program
- SECO Senate Bill 5 Program
- Electricity generated by wind farms in Texas (ERCOT)
- SEER13 upgrades to Single-family and Multi-family residences

The ESL's single-family and multi-family programs include the energy savings attained by constructing new residences in Texas according to the IECC 2000/2001 building code (IECC 2000). The baseline for comparison for the code programs is the published data on residential construction characteristics by the National Association of Home Builders (NAHB) for 1999 (NAHB 1999). Annual electricity (MWh) and natural gas (MBtu) savings are from the ESL's Annual Reports to the TCEQ (Haberl et al. 2002 - 2007).

The Public Utility Commission of Texas' Senate Bill and Senate Bill 7 programs include their incentive and rebates programs managed by the different Utilities for Texas (PUCT 2007). These include the Residential Energy Efficiency Programs (REEP) as well as the Commercial and Industrial Standard Offer Programs (C&I SOP). The energy-efficiency measures include high-efficiency HVAC equipment, variable speed drives, increased insulation levels, infiltration reduction, duct sealing, Energy Star Homes, etc. Annual electricity savings according to the utilities (or Power Control Authorities – PCAs) were reported for the different programs completed in the years 2001 through 2007. The PUCT also reported the savings from the Senate Bill 5 grant program which was conducted in 2002 and 2003.

The Texas State Energy Conservation Office funds energy-efficiency programs directed towards school districts, government agencies, city and county governments, private industries and residential energy consumers. For the 2007 reporting year, SECO submitted annual energy savings values for 149 projects which included projects funded by SECO and by Energy Service projects.

Electricity production from currently installed green power generation (wind) within the ERCOT region is reported. Projections through 2013 include planned projects provided by the PUCT; annual growth factors beyond 2013 comply with the Legislative requirements. Actual measured electricity production for 2001 through 2007 were included.

Finally, NOx emissions reductions from several other programs are also reported, including: energy-efficiency measures applied to Federal buildings in Texas, reductions from the elimination of pilot lights in residential furnaces, and reductions from the installation of SEER 13 air conditioners in existing residences.

9.2 Description of Analysis Method

Annual and Ozone Season Day NOx emissions reduction were calculated for 2007 and cumulatively from 2007 to 2020 using several factors to discount the potential savings. These factors include an annual degradation factor, a transmission and distribution factor, a discount factor and growth factors as shown in Table 9-1 and are described as follows:

Annual degradation factor: This factor was used to account for an assumed decrease in the performance of the measures installed as the equipment wears down and degrades. With the exception of electricity generated from wind, an annual degradation factor of 5% was used for all the programs. This value was taken from a study by Kats et al. (1996).

Transmission and distribution loss: This factor adjusts the reported savings to account for the loss in energy resulting from the transmission and distribution of the power from the electricity producers to the electricity consumers. For this calculation, the energy savings reported at the consumer level are increased by 7% to give credit for the actual power produced that is lost in the transmission and distribution system on its way to the customer. In the case of electricity generated by wind, the T&D losses were assumed to cancel out since wind energy is displacing power produced by conventional power plants; therefore, there is no net increase or decrease in T&D losses.

Initial discount factor: This factor was used to discount the reported savings for any inaccuracies in the assumptions and methods employed in the calculation procedures. For the ESL's single- and multi-family program, the discount factor was assumed to be 20%. For the PUCT's Senate Bill 5 and Senate Bill 2007 programs and electricity from wind, the discount factor was taken as 25%. For the savings in the SECO program, the discount factor was 60%.

Growth factor: The growth factors shown in Table 9-1 were used to account for several different factors. Growth factors for single-family (3.25%) and multi-family residential (1.54%) construction are projections based on the average growth rate for these housing types from recent U.S. Census data for Texas. Growth factors for wind energy are from the Texas Public Utilities Commission. No growth was assumed for Federal buildings, pilot lights, PUCT programs and SECO entries.

Figure 9-1 shows the overall information flow that was used to calculate the NOx emissions savings from the annual and Ozone Season Day (OSD) electricity savings (MWh) from all programs. For the ESL's single-family and multi-family code-implementation programs, the annual and ozone season savings were calculated from DOE-2 hourly simulation models. The base case is taken as the average characteristics of single- and multi-family residences for Texas published by the National Association of Home Builders for 1999 (NAHB 1999). The OSD consumption is the average daily consumption for the period between July 15 and September 15, 1999. The annual electricity savings from PUCT programs were calculated using deemed savings tables and spreadsheets created for the utilities incentive programs by Frontier Associates in Austin, Texas (PUCT 2007).

The SECO electricity savings were submitted as annual savings by project. A description of the measures completed for the project was also submitted for information purposes. The electricity production from wind farms in Texas was from the actual on-site metered data measured at 15-minute intervals.

Integration of the savings from the different programs into a uniform format allowed for creditable NOx emissions to be evaluated using different criteria as shown in Table 9-1. These include evaluation across programs, evaluation across individual counties by program, evaluation by SIP area, evaluation for all ERCOT counties except Houston/Galveston, and evaluation within a 200 km radius of Dallas/Ft. Worth.

9.3 Calculation Procedure

ESL Single-family and Multi-family: The calculation of the annual and OSD electricity savings reported for the years 2002 through 2007 included the savings from code-compliant new housing in all 41 non-attainment and affected counties as reported in the ESL's annual report submitted by the ESL to the Texas Commission of Environmental Quality. The savings for 2001 were also incorporated since some of the programs were reporting savings from September to December 2001. In 2005 to 2007, the annual and OSD electricity savings were calculated for new residential construction in all the counties in the ERCOT region, which includes the 41 non-attainment and affected counties. These savings were then tabulated by county and program. Using the calculated values through 2007, savings were then projected to 2020 by incorporating the different adjustment factors mentioned above.

In these calculations, it was assumed that the same amount of electricity savings from the code-complaint construction would be achieved for each year after 2007 through 2020[14]. The projected energy savings through 2020, according to county, were then divided into the different Power Control Authorities (PCA) in eGRID. To determine which PCA was to be used, or in counties with multiple PCA, the allocation to each PCA by county was obtained from the PUCT's listing published in the ESL's 2005 annual report[15].

For the 2007 annual and OSD NOx emissions calculations, the USEPA's 2007 eGRID were used[16]. An example of the eGRID spreadsheet[17] is given in Table 9-2. The total electricity savings for each PCA were used to calculate the NOx emissions reduction for each of the different counties using the emissions factors contained in eGRID. Similar calculations were performed for each year for which the analysis was required. The cumulative NOx emissions reduction for the electricity savings from residential new construction for 2006 through 2020 is provided in Table 9-3. NOx emissions reduction is provided in Table 9-4.

ESL-Commercial Buildings: The annual and OSD electricity savings for 2002 through 2007 for commercial buildings were obtained from the annual reports for 2005 and 2007 submitted by the ESL to the TCEQ[18]. These savings were also tabulated by county and program. Using the calculated values through 2007, savings were then projected to 2020 by incorporating the different adjustment factors mentioned above[19]. In the projected 2008 cumulative electricity savings was assumed that the same amount of electricity savings from 2007 would be achieved for each year after 2007 through 2020. Similarly to the single family calculations, the projected energy saving numbers through 2020, by county, were allocated into the appropriate Power Control Authorities (PCA).

Federal Buildings: Energy savings achieved from Energy Savings Performance Contracts (ESPCs) were also reported in 2007. This includes savings (estimated) from energy conservation measures implemented in Federal Buildings in Texas. The 2007 savings include projects implemented in 14 Federal buildings reported by the regional office of the Department of Energy. Annual kWh savings reported for each of the projects were divided by 365 to obtain the average Ozone Season Day savings[20]. In the calculation for 2007, it was assumed that the electricity savings from 2006 would also be achieved for each year from 2008 through 2020 after the appropriate degradation factors were applied. Similarly to the single family

[14] This would include the appropriate discount and degradation factors for each year.
[15] Haberl et al. 2005, pp. 197.
[16] This required two separate versions of the 2007 eGRID, which were specially prepared for Texas by Mr. Art Diem at the USEPA. One of the versions contains estimates of annual SOx, NOx and CO2 data for 2007 using a 25% capacity factor. The second version contains estimates of SOx, NOx and CO2 data for 2007 for an average day in the ozone season period, which runs from Mid July to Mid September.
[17] To use this spreadsheet, electricity savings for each PCA is entered in the bottom row of the spreadsheet (MWh). The spreadsheet then allocates the MWh of electricity savings according to the counties (blue columns) where the PCA owned and operated a power plant. Totals for all PCAs are then listed on the far right columns (white columns). Similar spreadsheets for the 2007 eGRID exist for SOx and CO2.
[18] These savings include new construction in office, assembly, education, retail, food, lodging and warehouse construction as defined by Dodge building type (Dodge 2005), using energy savings from the Pacific Northwest National Laboratory (USDOE 2004), and data from CBECS (1995 - 2003).
[19] This also includes the appropriate discount and degradation factors for each year.
[20] This method yields suitable OSD values for lighting retrofits and/or retrofits that are not weather dependent. In the case of retrofits to cooling systems, weather normalization would increase the OSD savings substantially. Retrofits to heating systems would be reduced by weather normalization.

calculations, the projected energy saving numbers through 2020, by county, were proportioned into the PUCT's Power Control Authorities (PCA) and the cumulative NOx emission reduction values calculated.

Furnace Pilot Light Program: For the furnace pilot light program savings, the N.G. energy savings achieved by retrofitting existing furnaces in single-family and multi-family residences for the entire residential stock for Texas have been projected until 2020. Pilot light removal saves an estimated 500 Btu/hr of natural gas for each hour of operation for the entire life of the furnace when the furnace is replaced with a code-compliant replacement. The energy savings for the Ozone Season Day are calculated by dividing the annual number by 365. It is also assumed that, of the total furnaces that were retrofitted, 75% were operational during the Ozone Season Period. Cumulative NOx emissions reduction for the N.G. savings from the removal of furnace pilot lights were also calculated by county for 2006 through 2020 by SIP area[21].

PUCT-Senate Bill 7: For the PUCT Senate Bill 7 program savings, the annual electricity savings for 2001 through 2007 were obtained from the Public Utilities Commission[22]. Using these values savings were projected through 2020 by incorporating the different adjustment factors mentioned above. Similar savings were assumed for each year after 2008 until 2020. The 2007 annual and OSD eGRID was also used to calculate the NOx emissions savings for the PUCT-Senate Bill 7 program. The total electricity savings for each PCA were used to calculate the NOx emissions reduction for each county using the emissions factors contained in the USEPA's eGRID spreadsheet. The cumulative NOx emissions reduction for each county by SIP area for the different programs was then calculated.

PUCT-Senate Bill 5 Grants Program: To calculate the annual electricity savings from the PUCT's Senate Bill 5 program, electricity savings were also obtained from the Public Utilities Commission[23]. The annual and average day electricity savings were then proportioned according to the PCA and program. Using the actual reported numbers through 2007, savings through 2020 were projected incorporating the different adjustment factors mentioned above[24]. The 2007 annual and OSD eGRID were used to calculate the NOx emissions savings for PUCT-Senate Bill 5 Grants Program. The total electricity savings for each PCA were used to calculate the NOx emissions reduction for each of the different counties.

SECO Savings: The annual electricity savings from energy conservation projects reported by political subdivisions for 35 counties through 2007 were obtained from the State Energy Conservation Office[25]. These submittals included information gathered from SECO's website[26] and paper submittals[27]. The annual and average day electricity values where then summarized according to county and program. Using the actual reported numbers for 2004, savings through 2020 were projected using the different adjustment factors mentioned above. In a similar fashion as the previous programs it was assumed that the same amount of electricity savings will be achieved for each year after 2005 until 2020. The 2007 annual and OSD eGRID were then used to calculate the NOx emissions savings for the SECO program.

[21] These use the NOx/MBtu values provided in the US EPA AP 42 guideline.
[22] In a similar fashion to the previous programs, to obtain the Ozone Season Day (OSD) savings, the annual electricity savings were divided by 365.
[23] In a similar fashion as the PUC's Senate Bill 7 program, the annual electricity savings numbers were then divided by 365 to get average electricity savings per day for OSD calculations. The preferred approach would be to weather-normalize the savings and then calculate savings for the OSD period. However, only annual values were obtained for the 2005 report to the TCEQ. Dividing the annual values by 365 is probably a reasonable approach for lighting projects. However, this undercounts potential savings from electric loads associated with the cooling season.
[24] Since the savings for the PUC's Senate Bill 5 were only reported for two years these savings actually reduced due to the imposed degradation factor.
[25] In a similar fashion as the PUC's Senate Bill 5 and 7 programs, these annual electricity savings numbers were divided by 365 to get average electricity savings per day for the OSD calculations.
[26] This web site was developed for SECO by the Laboratory at the request of the TCEQ.
[27] In these submittals, there were several municipalities whose electricity or natural consumption increased in 2004 as compared to 2001, which caused the reported savings from these municipalities to be negative. Since no additional information was reported from these projects that might have indicated what the cause of this was, it was assumed that the energy conservation projects were working as designed, but that other factors had changed the energy consumption. Therefore, in the final values of electricity savings from the political subdivisions that reported to SECO for the calculation of annual and OSD NOx reductions, the negative savings were omitted.

Electricity Generated by Wind Farms: The measured electricity production from all the wind farms in Texas for 2001 through 2007 was obtained from the Energy Reliability Council of Texas. To obtain the annual production, the 15-minute data were summed for the 12 months, while the data for the OSD period were converted to average daily electricity production during the months of July, August and September. Using the reported numbers for 2007, savings through 2020 were projected incorporating the different adjustment factors mentioned above. The 2007 annual and OSD eGRID were then used to calculate the NOx emissions reduction for the electricity generated by Texas' wind farms[28]. The total electricity savings for each PCA were used to calculate the NOx emissions reduction for each of the different counties.

SEER 13 Single-family and Multi-family: In January of 2006, Federal Regulations mandated that the minimum efficiency for residential air conditioners be increased to SEER 13 from the previous SEER 10. Although the electricity savings from new construction reflected this change in values, the annual and OSD electricity savings from the replacement of the air conditioning units by air conditioners with an efficiency of SEER 13 in existing residences needed to be calculated.

In the 2007 report to the TCEQ, the annual and OSD electricity savings for all the counties in the ERCOT region, as well as the 41 non-attainment and affected counties, was calculated for the retrofit. Using the numbers for 2007, the savings through 2020 were projected by incorporating the appropriate adjustment factors[29]. In this analysis it was assumed that an equal number of existing houses had their air conditioners replaced as reported for 2007 by the air conditioner manufacturers. This replacement rate continued until all the existing air conditioner stock was replaced with SEER 13 air conditioners. The total electricity savings for each PCA were used to calculate the NOx emissions reduction for each of the different county using the emissions factors contained in the 2007 eGRID. Cumulative NOx emissions reduction for each county by SIP area was also calculated.

9.4 Results

The total cumulative annual and OSD electricity savings for all the different programs in the integrated format was calculated using the adjustment factors shown in Table 9-1 for 2001 through 2020 as shown in Table 9-3. NOx emissions reduction from the electricity and natural gas savings for the annual and OSD for all the programs in the integrated format are shown in Table 9-4. In Table 9-3 and in Table 9-4, annual values are shown for 2005, and cumulative annual values are shown for 2006 through 2020. The annual and OSD NOx emissions reduction are also shown in Figure 9-2 and Figure 9-4 as stacked bar charts and in Figure 9-3 and Figure 9-5 for the individual components.

In 2007, (Table 9-3) the cumulative annual electricity savings[30] from code-compliant residential and commercial construction are calculated to be 1,440,885 MWh/year (11.4% of the total electricity savings); savings from retrofits to Federal buildings are 159,415 MWh/year (1.3%); savings from furnace pilot light retrofits are 2,548,904 MBtu/year; savings from the PUCT's Senate Bill 5 and Senate Bill 7 programs are 1,598,054 MWh/year (12.7%); savings from SECO's Senate Bill 5 program are 353,701 MWh/year (2.8%); electricity savings from green power purchases (wind) are 8,362,335 MWh/year (66.4%); and savings from residential air conditioner retrofits[31] are 677,171 MWh/year (5.4%). The total savings from all programs are 12,591,561 MWh/year.

In 2007, the cumulative OSD electricity savings from code-compliant residential and commercial construction are calculated to be 7,979 MWh/day (21.3%); savings from retrofits to Federal buildings are 437 MWh/day (1.2%); savings from furnace pilot light retrofits are 6,983 MBtu/day; savings from the PUCT's Senate Bill 5 and Senate Bill 7 programs are 4,378 MWh/day (11.7%); savings from SECO's

[28] This credited the electricity generated by the wind farm to the utility that either owned the wind farm or was associated with the wind farm owner.
[29] Additional details about this calculation are contained in the Laboratory's 2006 Annual Report to the TCEQ, available at the Senate Bill 5 web site "eslsb5.tamu.edu".
[30] This includes the savings from 2001 through 2007.
[31] This assumes air conditioners in existing homes are replaced with the more efficient SEER 13 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.

Senate Bill 5 program are 969 MWh/day (2.6%); electricity savings from green power purchases (wind) are 18,856 MWh/day (50.4%); and savings from residential air conditioner retrofits are 4,803 MWh/day (12.8%). The total savings from all programs are 37,421 MWh/day, which would be a 1,559 MW average hourly load reduction during the OSD period.

By 2013, the cumulative annual electricity savings from code-compliant residential and commercial construction are calculated to be 2,930,748 MWh/year (10.2% of the total electricity savings); savings from retrofits to Federal buildings will be 402,732 MWh/year (1.4%); savings from furnace pilot light retrofits will remain at 2,548,904 MBtu/year; savings from the PUCT's Senate Bill 5 and Senate Bill 7 programs will be 2,615,377 MWh/year (9.1%); savings from SECO's Senate Bill 5 program will be 447,285 MWh/year (1.5%); electricity savings from green power purchases (wind) will be 20,112,716 MWh/year (69.8%); and savings from residential air conditioner retrofits[32] will be 2,286,233 MWh/year (7.9%). The total savings from all programs will be 28,802,074 MWh/year.

By 2013, the cumulative OSD electricity savings from code-compliant residential and commercial construction are calculated to be 17,499 MWh/day (19.7%). savings from retrofits to Federal buildings will be 1,103 MWh/day (1.2%); savings from furnace pilot light retrofits will remain at 6,893 MBtu/day; savings from the PUCT's Senate Bill 5 and Senate Bill 7 programs will be 7,166 MWh/day (8.1%); savings from SECO's Senate Bill 5 program will be 1,225 MWh/day (1.4%); electricity savings from green power purchases (wind) will be 45,351 MWh/day (51.2%); and savings from residential air conditioner retrofits will be 16,216 MWh/day (18.3%). The total savings from all programs will be 88,560 MWh/day, which would be a 3,690 MW average hourly load reduction during the OSD period.

In 2007 (Table 9-4), the cumulative annual NOx emissions reduction[33] from code-compliant residential and commercial construction is calculated to be 1,014 tons-NOx/year (12.2% of the total NOx savings); savings from retrofits to Federal buildings are 122 tons-NOx/year (1.4%); savings from furnace pilot light retrofits are 117 tons-NOx/year (1.4%); savings from the PUCT's Senate Bill 5 and Senate Bill 7 programs are 1,125 tons-NOx/year (13.5%); savings from SECO's Senate Bill 5 program are 270 tons-NOx/year (3.2%); electricity savings from green power purchases (wind) are 5,211 tons-NOx/year (62.6%); and savings from residential air conditioner retrofits are 466 tons-NOx/year (5.6%). The total NOx emissions reductions from all programs are 8,326 tons-NOx/year.

In 2007, the cumulative OSD NOx emissions reduction from code-compliant residential and commercial construction is calculated to be 5.50 tons-NOx/day (21.9%); savings from retrofits to Federal buildings are 0.32 tons-NOx/day (1.2%); savings from furnace pilot light retrofits are 0.32 tons-NOx/day (1.2%); savings from the PUCT's Senate Bill 5 and Senate Bill 7 programs are 3.33 tons-NOx/day (12.1%); savings from SECO's Senate Bill 5 program are 0.73 tons-NOx/day (2.9%); electricity savings from green power purchases (wind) are 11.88 tons-NOx/day (47.4%); and savings from residential air conditioner retrofits are 3.27 tons-NOx/day (13.1%). The total NOx emissions reductions from all programs are 25.05 tons-NOx/day.

By 2013, the cumulative NOx emissions reduction from code-compliant residential and commercial construction is calculated to be 2,047 tons-NOx/year (10.9% of the total NOx savings); savings from retrofits to Federal buildings will be 308 tons-NOx/year (1.6%); savings from furnace pilot light retrofits will be 117 tons-NOx/year (0.6%); savings from the PUCT's Senate Bill 5 and Senate Bill 7 programs will be 1,801 tons-NOx/year (9.6%); savings from SECO's Senate Bill 5 program will be 341 tons-NOx/year (1.8%); electricity savings from green power purchases (wind) will be 12,534 tons-NOx/year (66.9%); and savings from residential air conditioner retrofits will be 1,574 tons-NOx/year (8.4%). The total NOx emissions reduction from all programs will be 18,723 tons-NOx/year.

[32] This assumes air conditioners in existing homes are replaced with the more efficient SEER 13 units, versus an average of SEER 11, which is slightly more efficient than the previous minimum standard of SEER 10.
[33] These NOx emissions reductions were calculated with the USEPA's 2007 eGRID for annual (25% capacity factor) and Ozone Season Day.

By 2013, the cumulative OSD NOx emissions reduction from code-compliant residential and commercial construction is calculated to be 11.96 tons-NOx/day (20.4%); savings from retrofits to Federal buildings will be 0.81 tons-NOx/day (1.4%); savings from furnace pilot light retrofits will be 0.32 tons-NOx/day (0.8 %); savings from the PUCT's Senate Bill 5 and Senate Bill 7 programs will be 4.84 tons-NOx/day (8.3%); savings from SECO's Senate Bill 5 program will be 0.92 tons-NOx/day (1.6%); electricity savings from green power purchases (wind) will be 28.58 tons-NOx/day (48.8%); and savings from residential air conditioner retrofits will be 11.03 tons-NOx/day (18.8%). The total NOx emissions reduction from all programs will be 58.47 tons-NOx/day.

Table 9-1: Final Adjustment Factors Used for the Calculation of the Annual and OSD NOx Savings for the Different Program.

	ESL-Single Family[16]	ESL-Multifamily[16]	ESL-Commercial[16]	Federal Buildings[15]	Furnace Pilot Light Program[15]	PUC (SB7)[15]	PUC (SB5 Grant Program)[15]	SECO[15]	Wind-ERCOT[8]	SEER13 Single Family	SEER13 Multifamily
Annual Degradation Factor [11]	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	5.00%	0.00%	5.00%	5.00%
T&D Loss [9]	7.00%	7.00%	7.00%	7.00%	0.00%	7.00%	7.00%	7.00%	0.00%	7.00%	7.00%
Initial Discount Factor [12]	20.00%	20.00%	20.00%	20.00%	20.00%	25.00%	25.00%	60.00%	25.00%	20.00%	20.00%
Growth Factor	3.25%	1.54%	3.25%	0.00%	0.00%	0.00%	0.00%	0.00%	Actual Rates	N.A.	N.A.
Weather Normalized	Yes	Yes	Yes	No	No	No	No	No	See note 7	Yes	Yes

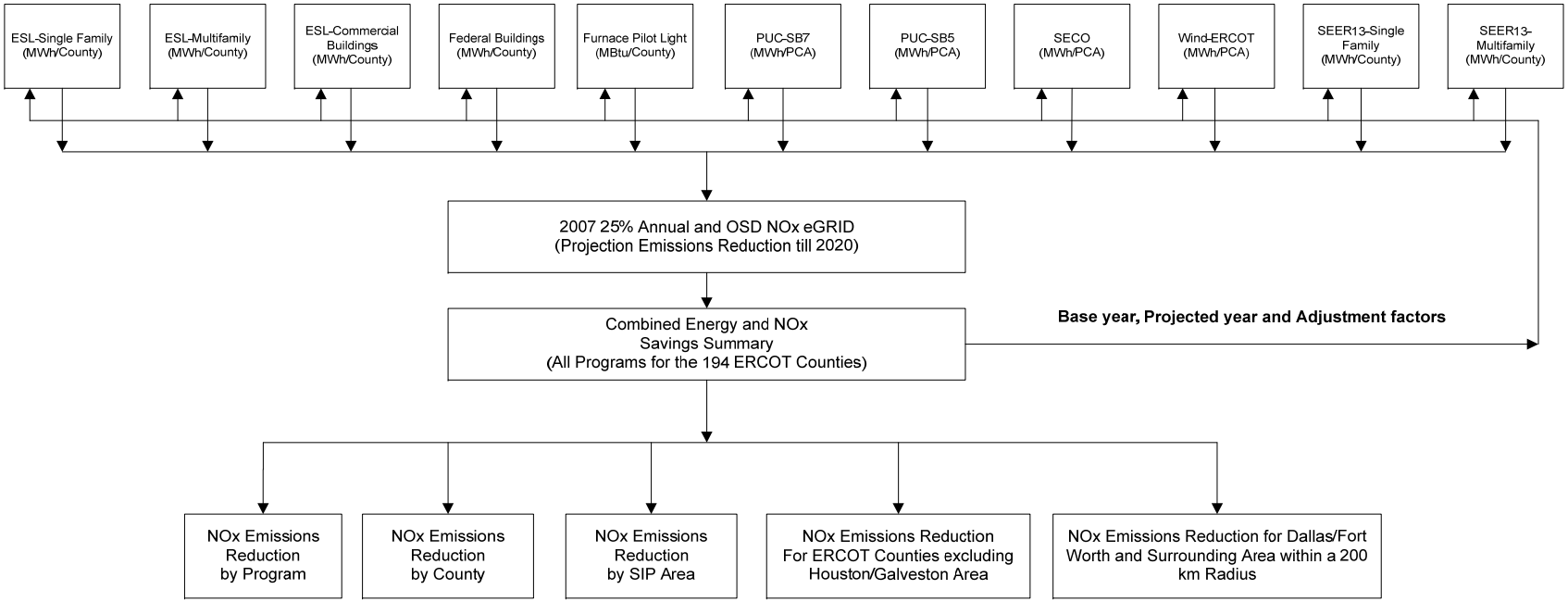


Figure 9-1: Process Flow Diagram of the NOx Emissions Reduction Calculations.

Table 9-2: Example of NOx Emissions Reduction Calculations using eGRID.

Area	County	American Electric Power - West (ERCOT) /PCA	NOx Reductions (lbs)	Austin Energy/PCA	NOx Reductions (lbs)	Brownsville Public Utils Board/PCA	NOx Reductions (lbs)	Lower Colorado River Auhotrity /PCA	NOx Reductions (lbs)	Reliant Energy HL&P/PCA	NOx Reductions (lbs)	San Antonio Public Service Bd/PCA	NOx Reductions (lbs)	South Texas Electric Coop INC/PCA	NOx Reductions (lbs)	Texas Municipal Power Pool/PCA	NOx Reductions (lbs)	Texas-New Mexico Power Co/PCA	NOx Reductions (lbs)	TXU Electric/PCA	NOx Reductions (lbs)	Total Nox Reductions (lbs)	Total Nox Reductions (Tons)
Houston-Galveston Area	Brazoria	0.008831132	226.0465792	0.010890729	8.193488679	0.006522185	0	0.003944232	14.32402746	0.065444292	3035.079423	0.014877434	272.3666894	0.006262315	0	0.004817148	0	0.12127495	139.7235344	0.00816387	940.7285451	4636.462287	2.318231144
	Chambers	0.021762222	557.0379581	0.026955801	20.27982242	0.016072371	0	0.009076193	32.96145962	0.16494022	7649.355979	0.037472294	686.0191605	0.015055623	0	0.009553214	0	0.011518588	13.2708178	0.015818592	1822.787617	10781.71281	5.390856407
	Fort Bend	0.070431234	1802.797078	0.087239726	65.63359654	0.052016606	0	0.029372482	106.6764342	0.533812376	24756.36787	0.121275295	2220.231709	0.048726002	0	0.037278747	0	42.94966114	0.051195276	5899.267979	34893.92432	17.44696216
	Galveston	0.033856739	866.6159501	0.041710519	31.3803294	0.025004711	0	0.015351589	55.75143316	0.249587379	11574.99759	0.056747051	1038.889275	0.024143087	0	0.019297151	0	0.567751219	654.118618	0.032836887	3783.817742	18005.57093	9.002785467
	Harris	0.068267332	1747.408655	0.084559408	63.61709594	0.050418468	0	0.028471701	103.3989497	0.517411736	23996.76304	0.117549281	2152.01819	0.047228963	0	0.029968099	0	0.03613341	41.63009278	0.049622373	5718.021208	33821.85723	16.91092861
	Liberty	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Montgomery	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Waller	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Beaumont/ Port Arthur Area	Hardin	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Jefferson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Orange	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dallas/ Fort Worth Area	Collin	0.002039135	52.19483875	0.003716345	2.795940278	0.001505992	0	0.005950953	21.61171382	0.002481478	115.0823578	0.000717051	13.12731328	0.019166247	0	0.07668094	0	0.00086441	0.995905867	0.004000199	460.945804	666.7538738	0.333376937
	Dallas	0.004539471	116.1948312	0.004683963	3.523914222	0.003352602	0	0.00774211	28.1165509	0.002085611	96.72341896	0.00068106	12.46842352	0.007502816	0	0.026717045	0	0.00752493	8.669640256	0.040370454	4651.916039	4917.612818	2.458806409
	Denton	0.00047388	12.12970385	0.000872802	0.656640103	0.000349962	0	0.001396994	5.073377767	0.000585443	27.15083393	0.000168971	3.093405773	0.00454374	0	0.018187155	0	0.000186605	0.214992277	0.000849405	97.87758499	146.1965387	0.073096269
	Tarrant	0.012162492	311.3179263	0.012266309	9.228387517	0.008982543	0	0.020308652	73.75369976	0.005316504	246.5610524	0.001752506	32.08377752	0.017326428	0	0.066216761	0	0.020603444	23.73767965	0.110647237	12749.95959	13446.64211	6.723321056
	Ellis	0.003279814	83.95193355	0.003307809	2.488584531	0.002422289	0	0.005476558	19.88888265	0.001433682	66.48919108	0.000472592	8.651911537	0.004672353	0	0.005556053	0	0.001238427	0.290837824	0.029837824	3438.233618	3626.105373	1.813052686
	Johnson	0.000286058	7.322112154	0.000526868	0.396381687	0.000211267	0	0.000843297	3.062551359	0.000353404	16.38963767	0.000101999	1.867338584	0.002742835	0	0.010978701	0	0.000112645	0.129780379	0.000512745	59.08393672	88.25173856	0.044125869
	Kaufman	0.006325453	161.9098051	0.006379446	4.799487271	0.004671629	0	0.010562096	38.3577242	0.002765	128.2311379	0.000911441	16.68608752	0.009011105	0	0.031731452	0	0.010715411	12.34546025	0.057545265	6630.9817	6993.311403	3.496655701
	Parker	0.000217489	5.568981877	0.000400576	0.301367914	0.000160626	0	0.000641157	2.328449436	0.000268692	12.46099677	7.75498E-05	1.419732426	0.00208537	0	0.008347076	0	8.56434E-05	0.098671668	0.000399838	44.92135575	67.09755584	0.033548778
	Rockwall	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Henderson	0.000819895	20.9846722	0.000826893	0.622101782	0.000605529	0	0.001369042	4.971866208	0.000358395	16.62111282	0.00011814	2.162823693	0.001168005	0	0.001388914	0	0.001388914	1.600198603	0.007458924	859.4971295	906.4617199	0.45323086
	Hood	0.01252711	320.6508812	0.012634039	9.505044007	0.009251829	0	0.020917482	75.96475123	0.005475887	253.9526704	0.001805044	33.04561243	0.017845854	0	0.062021991	0	0.021221112	24.4493081	0.113964315	13132.18878	13849.75705	6.924878523
	Hunt	0.006187558	158.3801895	0.006240374	4.694858985	0.004569788	0	0.010331844	37.5215301	0.002704724	125.4357135	0.000891572	16.32233268	0.008814664	0	0.030634735	0	0.010481817	12.0763306	0.056290785	6486.427041	6840.857996	3.420428998
El Paso Area	El Paso	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
San Antonio Area	Bexar	0.033413751	855.276978	0.051775843	38.95283667	0.024677545	0	0.090663423	329.2568536	0.001141841	52.95463998	1.143571754	20935.7914	0.046873844	0	0.004669544	0	0.000519582	0.598622181	0.002503865	288.5221599	22501.3535	11.25067675
	Comal	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Guadalupe	0.002000467	51.20507169	0.076378745	57.46248772	0.001477434	0	0.133848731	486.0903138	0.001237133	57.37392999	0.003554796	65.07897116	0.001061766	0	0.001855699	0	0.000401718	0.462828487	0.001835165	211.4673431	929.140946	0.464570473
	Wilson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Austin Area	Bastrop	0.004502334	115.2442433	0.171901148	129.3274415	0.003325174	0	0.301245466	1094.014881	0.002784342	129.1281298	0.008000571	146.4694129	0.002389654	0	0.004176513	0	0.000904124	1.041660805	0.004130298	475.937112	2091.162881	1.04558144
	Caldwell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hays	0.002458599	62.93167289	0.093870431	70.62211537	0.001815785	0	0.164501762	597.4110691	0.001520452	70.51327681	0.004368899	79.98286869	0.001304924	0	0.002280677	0	0.000493717	0.568821994	0.00225544	259.8960069	1141.925832	0.570962916
	Travis	0.000510007	13.05442349	0.299602906	225.4020851	0.000376663	0	0.033939476	123.2559365	0.000334709	15.52263338	0.000906121	16.58869273	0.000271138	0	0.000471744	0	0.000103327	0.119045148	0.000467336	53.85143207	447.7942484	0.223897124
	Williamson	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North East Texas Area	Gregg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Harrison	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Rusk	0.000685965	17.55833805	0.00069182	0.520481264	0.000506616	0	0.001145408	4.159710327	0.000299851	13.90604891	9.88414E-05	1.809525774	0.000977211	0	0.003396227	0	0.001162035	1.338805667	0.006240507	719.0980079	758.3909179	0.379195459
	Smith	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Upshur	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corpus Christi Area	Nueces	0.22756873	5824.975938	0.004556851	3.428283791	0.168069652	0	0.007612767	27.64682441	0.001680888	77.95375313	0.001626796	29.78235622	0.046792036	0	0.001609426	0	0.001609426	1.854254911	0.008283395	954.5014455	6920.142856	3.460071428
	San Patricio	0.050313351	1287.848557	0.001007478	0.757961986	0.037158653	0	0.001683113	6.112458369	0.000371629	17.2348572	0.00035967	6.584604794	0.010345288	0	0.001602105	0	0.000355829	0.409958691	0.001831382	211.0314828	1529.979881	0.76498994
Victoria Area	Victoria	0.021836736	558.9452467	0.002215582	1.666862472	0.016127403	0	0.003612695	13.12000619	0.001199621	55.63426979	0.000555389	10.16770824	0.52545648	0	0.003412721	0	0.000476855	0.549395481	0.002254849	259.8278678	899.9113567	0.449955678
	Andrews	2.47421E-05	0.633312154	2.49533E-05	0.018772251	1.82731E-05	0	4.13138E-05	0.150036693	1.08115E-05	0.501577619	3.56511E-06	0.065267829	3.52477E-05	0	4.19135E-05	0	4.04828941	0.000122499	27.35442065	0.013677271		
	Angelina	0.00031082	7.955919749	0.000313473	0.235837079	0.000229554	0	0.000519	1.884820844	0.000135867	6.301018286	4.47864E-05	0.81992053	0.000442787	0	0.001538876	0	0.000526534	0.606630902	0.002827658	325.8330045	343.6371519	0.171818576
	Bosque	0.000595392	15.23997933	0.001096604	0.825014503	0.000439723	0	0.001755208	6.374283599	0.000735562	34.11279889	0.000212298	3.88661097	0.005708837	0	0.02285067	0	0.000234455	0.270120186	0.001067208	122.9751683	183.6839758	0.091841988
	Brazos	0.001939725	49.65028649	0.003572622	2.687812467	0.001432574	0	0.005718288	20.7667609	0.002396384	111.1359931	0.000691644	12.66217912	0.018598805	0	0.074445136	0	0.000763829	0.880023807	0.003476855	400.6404605	598.4235164	0.299217158
	Calhoun	0.082699809	2116.830355	0.001659986	1.245858399	0.061077496	0	0.002766524	10.04701783	0.000610844	28.32885022	0.000591187	10.8230826	0.01700445	0	0.002633372	0	0.000584875	0.673847089	0.003010234	346.8714129	2514.820424	1.257410212
	Cameron	0.048371747	1238.150172	0.000968599	0.728712051	0.29796476	0	0.001618161	5.876577133	0.000357288	16.56975992	0.00034579	6.330503314	0.009946081	0	0.000342098	0	0.000342098	0.394138287	0.001760709	202.8877272	1470.93759	0.735468795
	Cherokee	0.003503899	89.68774747	0.003533808	2.658611083	0.002587786	0	0.00585073	21.24774271	0.001531635	71.03190513	0.00050488	9.243032581	0.00499158	0	0.017347879	0	0.005935657	6.838600793	0.031876422	3673.14266	3873.8503	1.93692515
	Coke	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Coleman	0.001298787	33.24447222	2.6007E-05	0.019566001	0.000959212	0	4.34478E-05	0.157786761	9.59321E-06	0.444899929	9.2845E-06	0.16997473	0.000267053	0	4.13567E-05	0	9.18536E-06	0.010582658	4.72752E-05	5.447558433	39.4948073	0.01974742
	Crockett	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Ector	0.003535746	90.50296541	0.003565928	2.682776563	0.002611307	0	0.005903911	21.44067434	0.001545556	71.67755054	0.0005094	9.327047245	0.005036951	0	0.00598961	0	0.001755563	6.900760344	0.032166163	3706.529738	3909.061712	1.954530856
	Fannin	0.007056315	180.6173605	0.007116546	5.354034748	0.005211403	0	0.011782473	42.78969328	0.003084477	143.0473568	0.001016752	18.61404924	0.010052276	0	0.034935966	0	0.011953503	13.77189259	0.064194222	7397.14566	7801.340048	3.900670024
	Fayette	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Freestone	0.003677178	94.12308401	0.003708565	2.790087625	0.00271576	0	0.006140067	22.29850932	0.001607379	74.54465257	0.000529848	9.700129134	0.005238429	0	0.018205786	0	0.006229184	7.176790757	0.033452809	3854.790927	4065.42418	2.03271209
	Frio	0.008588335	219.8317964	0.000871383	0.655572927	0.006342868	0	0.00142086	5.160066298	0.000471809	21.88082203	0.000218433	3.998934744	0.206660746	0	0.012747844	0	0.000187546	0.216075897	0.000886827	102.189664	353.9329323	0.176966469
	Grimes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Hardeman	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Haskell	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other ERCOT counties	Hidalgo	0.188527456	4825.653746	0.003775086	2.840133709	0.139235931	0	0.006306735	22.9037859	0.001392518	64.58015017	0.001347706	24.6729498	0.03876448	0	0.006003193	0	0.001333316	1.536142338	0.006862311	790.7489276	5732.935836	2.866467918
	Howard	0.000555113	14.20898268	0.000559851	0.421196428	0.000409976	0	0.000926915	3.366221326	0.000242653	11.25338899	7.99868E-05	1.464348181	0.000790802	0	0.002748377	0	0.000094037	0.108320679	0.000505094	581.9258697	613.723428	0.306861714
	Jack	0.002121449	54.30177924	0.002139557	1.609633938	0.001566784	0	0.003542346	12.86452461	0.000927334	43.00653033	0.000305682	5.596228347	0.00302217	0	0.010503338	0	0.003593766	4.140456206	0.019299698	2223.917843	2345.437027	1.172718514
	Jones	0.040718722	1042.259088	0.000815354	0.613420549	0.030072592	0	0.001362147	4.946827986	0.00030076	13.94821343	0.000291082	5.32893728	0.008372468	0	0.001296587	0	0.000287974	0.331780603	0.001482142	170.7883116	1238.216579	0.61910829
	Lamar	0.000950938	24.33817497	0.000959954	0.721455757	0.000702236	0	0.001587683	5.765907769	0.000415633	19.27561906	0.000137007	2.508241656	0.001354553	0	0.004707619	0	0.001610734	1.855761432	0.008650166	996.7647898	1051.229951	0.525614976
	Limestone	0.000719757	18.42329542	0.000891526	0.670728366	0.000531572	0	0.000300183	1.090156782	0.00545533	252.9923553	0.001239347	22.68917849	0.00497945	0	0.000380962	0	0.438914787	0.000523179	66.28629516	356.5909243	0.178295462	
	Llano	0.001238174	31.69299001	0.047274044	35.56597012	0.000914447	0	0.082844655	300.8619059	0.000765714	35.51115798	0.002200214	40.28013466	0.000657172	0	0.001148571	0	0.000248641	0.286464175	0.001135861	130.8861051	575.0847279	0.287542364
	McLennan	0.024534317	627.9940467	0.024743738	18.61560781	0.018119687	0	0.004966843	148.7767984	0.010724513	497.3657473	0.003535175	64.71975936	0.034961916	0	0.121469933	0	0.041561501	47.88391622	0.22319886	25719.36288	27124.71876	13.56235938
	Milam	0.002245405	57.4746348	0.002264571	1.703718789	0.001658332	0	0.003749326	13.61619935	0.000981518	45.51940379	0.000323543	5.923216218	0.003198756	0	0.011117048	0	0.003380375	4.382383245	0.02042738	2353.86146	2482.481018	1.241240508
	Mitchell	0.014943169	382.4936868	0.015070721	11.3382478	0.011036196	0	0.024951762	90.61580067	0.006532002	302.9316123	0.002153177	39.41900132	0.02128772	0	0.07398395	0	0.025313952	29.16475857	0.135944204	15664.94698	16520.91007	8.260455038
	Nolan	0.000564654	14.45319062	0.000569473	0.428435476	0.000417022	0	0.000942848	3.424076134	0.000246823	11.44679952	8.13615E-05	1.489515743	0.000804394	0	0.002795613	0	0.000956532	1.102041289	0.005136889	591.9273539	624.2714127	0.312135706
	Palo Pinto	0.003206998	82.08811543	0.005906709	4.443830552	0.002368511	0	0.009454195	34.33422818	0.003962005	183.7440401	0.001143513	20.93471146	0.030749688	0	0.123082087	0	0.001262858	1.454966345	0.005748375	662.3893373	989.3892293	0.494694615
	Pecos	4.09677E-05	1.048631523	4.13174E-05	0.031084551	3.02565E-05	0	6.84069E-05	0.248429171	1.79079E-05	0.830506919	5.90308E-06	0.108069782	5.83617E-05	0	6.93999E-05	0	6.93999E-05	0.079957102	0.0003727	42.94648142	45.29316047	0.02264658
	Presidio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Red River	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Robertson	0.000737708	18.88277792	0.000835096	0.628273174	0.00054483	0	0.000735917	2.67258533	0.003149678	146.0711407	0.000730875	13.38040458	0.00076086	0	0.001866305	0	0.191632518	220.7840225	0.003397737	391.5236901	793.9428943	0.396971447
	Taylor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Titus	0.005696437	145.8091831	0.005745061	4.322217039	0.004207073	0	0.009511781	34.5435843	0.002490043	115.4795873	0.000820806	15.02679093	0.008115023	0	0.028203184	0	0.00964985	11.11780398	0.051822854	5971.584145	6297.883086	3.148941543
	Tom Green	0.001482448	37.94556588	2.96846E-05	0.022332825	0.001094854	0	4.9591BE-05	0.180099353	1.09498E-05	0.507813132	1.05974E-05	0.19401082	0.000304817	0	4.72049E-05	0	1.04843E-05	0.012079149	5.39604E-05	6.217896494	45.07979763	0.022539899
	Upton	3.11661E-05	0.797745539	3.14322E-05	0.023647546	2.30176E-05	0	5.20405E-05	0.188992281	1.36234E-05	0.631807433	4.49076E-06	0.082213995	4.43986E-05	0	0.000154304	0	5.27959E-05	0.060827297	0.000283531	32.67149923	34.45673333	0.017228367
	Ward	0.018559529	475.0600294	0.01871795	14.08218954	0.013707039	0	0.030990277	112.54551	0.008112796	376.2433542	0.002674262	48.95869786	0.026439508	0	0.093188626	0	0.03144012	36.22285079	0.16884373	19455.98267	20519.0953	10.25954765
	Webb	0.020014327	512.2978652	0.000400768	0.301512399	0.014781473	0	0.000669531	2.431496589	0.000147832	6.855915242	0.000143074	2.619313398	0.004115289	0	0.000637307	0	0.000141547	0.163078928	0.000728512	83.94696529	608.6161471	0.304308074
	Wharton	0.00014434	3.694599265	0.000178787	0.134507561	0.000106601	0	0.01986E-05	0.218619544	0.001093979	50.7349716	0.000248538	4.550077512	9.98576E-05	0	7.639E-05	0	7.639E-05	0.088019771	0.000104918	12.08978615	71.5105814	0.035755291
	Wichita	0.000207633	5.314695266	0.000209406	0.157543345	0.000153346	0	0.000346701	1.259093698	9.07612E-05	4.209191786	2.99181E-05	0.547721432	0.00029579	0	0.000351734	0	0.405240184	0.001888925	217.6622165	229.5557022	0.114777851	
	Wilbarger	0.028616818	732.4920115	0.000573025	0.431107444	0.021134796	0	0.000957307	3.476594279	0.000211372	9.802701684	0.00020457	3.745137877	0.005884109	0	0.000911232	0	0.000202386	0.233172965	0.001041639	120.0287677	870.2094935	0.435104747
	Wise	0.002844488	72.80908734	0.002882008	2.16823872	0.002100781	0	0.00476997	17.32281236	0.001256075	58.25242144	0.000413241	7.565361234	0.004181914	0	0.004797945	0	0.004797945	5.527817073	0.025761411	2968.505674	3132.151412	1.566075706
	Young	0.006235856	159.6164509	0.006289085	4.73150543	0.004605458	0	0.010412491	37.81441029	0.002725836	126.4148216	0.000898531	16.44973921	0.009883468	0	0.03087389	0	0.010563634	12.17059429	0.056730171	6537.057865	6894.255386	3.447127693
	Total	**1.121837219**	**28715.17018**	**1.172570994**	**882.1668247**	**1.090766584**	**0**	**1.189130767**	**4318.494099**	**1.629360606**	**75564.06999**	**1.54236264**	**28236.60382**	**1.359385821**	**0**	**1.221806085**	**0**	**1407.669558**	**1.528786947**		**176163.2035**	**315287.3779**	**157.643689**
Energy Savings by PCA (MWh)		25,597		752		0		3,632		46,377		18,307		0		0		1,152		115,231			

Table 9-3: Annual and OSD Electricity Savings for the Different Programs.

Program	2005	Cumulative 2006	Cumulative 2007	Cumulative 2008	Cumulative 2009	Cumulative 2010	Cumulative 2011	Cumulative 2012	Cumulative 2013	Cumulative 2014	Cumulative 2015	Cumulative 2016	Cumulative 2017	Cumulative 2018	Cumulative 2019	Cumulative 2020
	Annual (MWh)	Annual (MWh)	Annual (MWh)	Annual (MWh)	Annual (MWh)	Annual (MWh)	Annual (MWh)	Annual (MWh)	Annual (MWh)	Annual (MWh)	Annual (MWh)	Annual (MWh)	Annual (MWh)	Annual (MWh)	Annual (MWh)	Annual (MWh)
ESL-Single Family	225,389	1,001,051	1,197,537	1,389,628	1,576,914	1,758,988	1,935,443	2,105,869	2,269,858	2,427,002	2,576,894	2,719,125	2,853,286	2,978,970	3,095,768	3,203,273
ESL-Multifamily	9,228	37,821	51,312	64,266	76,670	88,513	99,783	110,468	120,555	130,032	138,889	147,113	154,691	161,612	167,865	173,436
ESL-Commercial	63,456	129,063	192,036	253,790	314,214	373,193	430,615	486,367	540,335	592,407	642,470	690,410	736,114	779,469	820,362	858,680
Federal Buildings	52,276	109,073	159,415	206,960	251,708	293,659	332,813	369,171	402,732	433,496	461,464	486,635	509,009	528,586	545,366	559,350
Furnace Pilot Light Program	2,209,050	2,548,904	6,983	2,548,904	6,983	2,548,904	6,983	2,548,904	6,983	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904	2,548,904
PUC (SB7)	302,192	1,362,701	1,585,227	1,792,849	1,985,566	2,163,378	2,326,285	2,474,288	2,607,386	2,725,579	2,828,867	2,917,251	2,990,730	3,049,304	3,092,973	3,121,738
PUC (SB5 grant program)	0	13,633	12,827	12,021	11,215	10,409	9,603	8,797	7,991	7,186	6,380	5,574	4,768	3,962	3,156	2,350
SECO	115,360	293,764	353,701	389,150	404,524	418,025	429,652	439,405	447,285	453,292	457,425	459,684	460,070	458,582	455,220	449,985
Wind-ERCOT	2,867,049	6,376,678	8,362,335	12,722,008	16,867,714	18,517,389	18,947,739	19,521,539	20,112,716	20,721,795	21,349,319	21,995,847	22,661,954	23,348,233	24,055,294	24,783,768
SEER13-Single Famil	0	374,246	624,639	913,010	1,185,311	1,441,594	1,681,860	1,906,108	2,114,339	2,306,551	2,482,746	2,642,923	2,787,083	2,915,224	2,803,568	2,590,509
SEER13-Multifamily	0	31,634	52,532	76,375	98,620	119,281	138,371	155,904	171,894	186,354	199,298	210,738	220,690	229,165	219,722	202,900
	OSD (MWh)	OSD (MWh)	OSD (MWh)	OSD (MWh)	OSD (MWh)	OSD (MWh)	OSD (MWh)	OSD (MWh)	OSD (MWh)	OSD (MWh)	OSD (MWh)	OSD (MWh)	OSD (MWh)	OSD (MWh)	OSD (MWh)	OSD (MWh)
ESL-Single Family	776	5,537	6,519	7,702	8,857	10,157	11,235	12,276	13,279	14,241	15,160	16,034	16,859	17,633	18,355	19,021
ESL-Multifamily	36	192	271	355	434	517	589	658	723	784	841	895	944	989	1,031	1,068
ESL-Commercial	0	800	1,189	1,595	1,992	2,401	2,777	3,143	3,497	3,839	4,167	4,482	4,782	5,067	5,336	5,588
Federal Buildings	0	299	437	567	690	805	912	1,011	1,103	1,188	1,264	1,333	1,395	1,448	1,494	1,532
Furnace Pilot Lt Prog. (Mbtu)	5,819	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983
PUC (SB7)	828	3,733	4,343	4,912	5,440	5,927	6,373	6,779	7,144	7,467	7,750	7,992	8,194	8,354	8,474	8,553
PUC (SB5 grant program)	0	37	35	33	31	29	26	24	22	20	17	15	13	11	9	6
SECO	316	805	969	1,066	1,108	1,145	1,177	1,204	1,225	1,242	1,253	1,259	1,260	1,256	1,247	1,233
Wind-ERCOT	5,836	13,740	18,856	28,686	38,034	41,754	42,724	44,018	45,351	46,724	48,139	49,597	51,099	52,647	54,241	55,884
SEER13-Single Famil	0	2,666	4,449	6,503	8,442	10,268	11,979	13,576	15,059	16,428	17,683	18,824	19,851	20,764	19,969	18,451
SEER13-Multifamily	0	213	354	514	664	803	931	1,049	1,157	1,254	1,341	1,418	1,485	1,542	1,479	1,365
Total Ann (MWh)	5,843,999	12,278,567	12,598,545	20,368,960	22,779,439	27,733,334	26,339,148	30,126,820	28,802,074	32,532,599	33,692,655	34,824,202	35,927,296	37,002,010	37,808,199	38,494,893
Total OSD (MWh)	7,791	28,023	37,421	51,933	65,693	73,805	78,724	83,739	88,560	93,187	97,618	101,850	105,882	109,712	111,633	112,701
Total OSD (Mbtu)	5,819	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983	6,983

Table 9-4: Annual and OSD NOx Emissions Reduction Values for the Different Programs.

Program	2005	Cum. 2006	Cum. 2007	Cum. 2008	Cum. 2009	Cum. 2010	Cum. 2011	Cum. 2012	Cum. 2013	Cum. 2014	Cum. 2015	Cum. 2016	Cum. 2017	Cum. 2018	Cum. 2019	Cum. 2020
	Annual (Tons)	Annual (Tons)	Annual (Tons)	Annual (Tons)	Annual (Tons)	Annual (Tons)	Annual (Tons)	Annual (Tons)	Annual (Tons)	Annual (Tons)	Annual (Tons)	Annual (Tons)	Annual (Tons)	Annual (Tons)	Annual (Tons)	Annual (Tons)
ESL-Single Family	158	708	843	975	1,103	1,228	1,349	1,466	1,579	1,687	1,790	1,887	1,979	2,065	2,145	2,218
ESL-Multifamily	6	26	35	44	53	61	69	76	83	90	96	101	107	111	116	120
ESL-Commercial	44	90	136	180	223	265	307	347	385	423	459	493	526	557	586	614
Federal Buildings	40	84	122	158	193	225	255	283	308	332	353	373	390	405	418	428
Furnace Pilot Light Program	102	117	117	117	117	117	117	117	117	117	117	117	0	0	0	0
PUC (SB7)	237	1,074	1,120	1,259	1,387	1,504	1,612	1,710	1,798	1,875	1,942	2,000	2,047	2,084	2,111	2,300
PUC (SB5 grant program)	0	6	5	5	5	4	4	4	3	3	3	2	2	2	1	1
SECO	67	224	270	297	308	319	328	335	341	346	349	350	351	350	347	343
Wind-ERCOT	2,465	3,971	5,211	7,928	10,511	11,539	11,808	12,165	12,534	12,913	13,304	13,707	14,122	14,550	14,990	15,444
SEER13-Single Family	0	258	430	629	816	993	1,158	1,313	1,456	1,589	1,710	1,820	1,920	2,008	1,931	1,784
SEER13-Multifamily	0	22	36	53	68	82	95	107	118	128	137	145	152	158	151	140
	OSD (Tons)	OSD (Tons)	OSD (Tons)	OSD (Tons)	OSD (Tons)	OSD (Tons)	OSD (Tons)	OSD (Tons)	OSD (Tons)	OSD (Tons)	OSD (Tons)	OSD (Tons)	OSD (Tons)	OSD (Tons)	OSD (Tons)	OSD (Tons)
ESL-Single Family	0.76	3.85	4.50	5.30	6.07	6.95	7.68	8.38	9.05	9.70	10.31	10.90	11.45	11.97	12.45	12.90
ESL-Multifamily	0.03	0.13	0.18	0.24	0.30	0.35	0.40	0.45	0.49	0.53	0.57	0.61	0.64	0.67	0.70	0.73
ESL-Commercial	0.26	0.55	0.82	1.10	1.38	1.66	1.92	2.17	2.42	2.65	2.88	3.10	3.31	3.51	3.69	3.87
Federal Buildings	0.11	0.22	0.32	0.42	0.51	0.59	0.67	0.74	0.81	0.87	0.93	0.98	1.02	1.06	1.10	1.12
Furnace Pilot Light Program	0.28	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.00	0.00	0.00	0.00
PUC (SB7)	0.64	2.61	3.01	3.38	3.73	4.04	4.33	4.60	4.83	5.04	5.22	5.38	5.50	5.60	5.68	5.72
PUC (SB5 grant program)	0.00	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00
SECO	0.18	0.61	0.73	0.80	0.84	0.86	0.89	0.91	0.92	0.94	0.95	0.95	0.95	0.95	0.94	0.93
Wind-ERCOT	5.85	8.59	11.88	18.08	23.97	26.31	26.92	27.74	28.58	29.44	30.34	31.26	32.20	33.18	34.18	35.22
SEER13-Single Family	0.00	1.81	3.03	4.42	5.74	6.98	8.15	9.23	10.24	11.17	12.03	12.80	13.50	14.12	13.58	12.55
SEER13-Multifamily	0.00	0.15	0.24	0.35	0.45	0.55	0.63	0.71	0.79	0.85	0.91	0.97	1.01	1.05	1.01	0.93
Total Ann	3,119	6,579	8,326	11,644	14,785	16,339	17,102	17,923	18,723	19,502	20,260	20,996	21,594	22,289	22,796	23,392
Total OSD	8.09	18.85	25.05	34.42	43.31	48.64	51.92	55.26	58.47	61.54	64.47	67.26	69.60	72.12	73.33	73.97

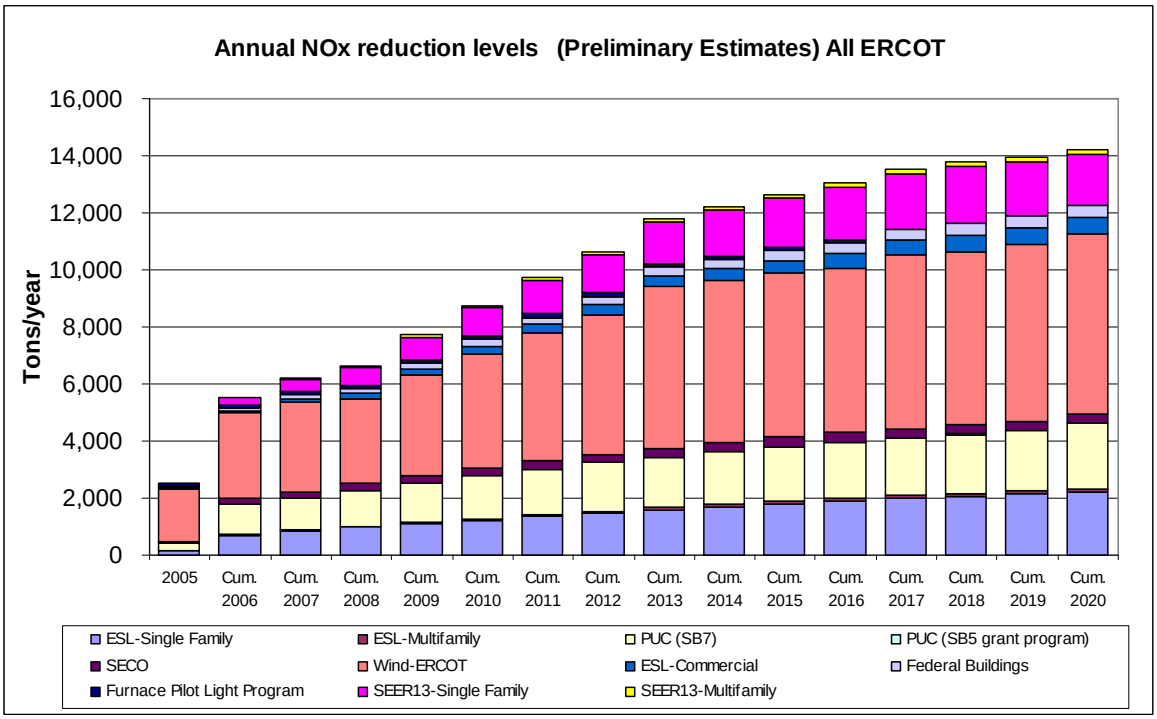


Figure 9-2: Cumulative OSD NOx Emissions Reduction Projections through 2020.

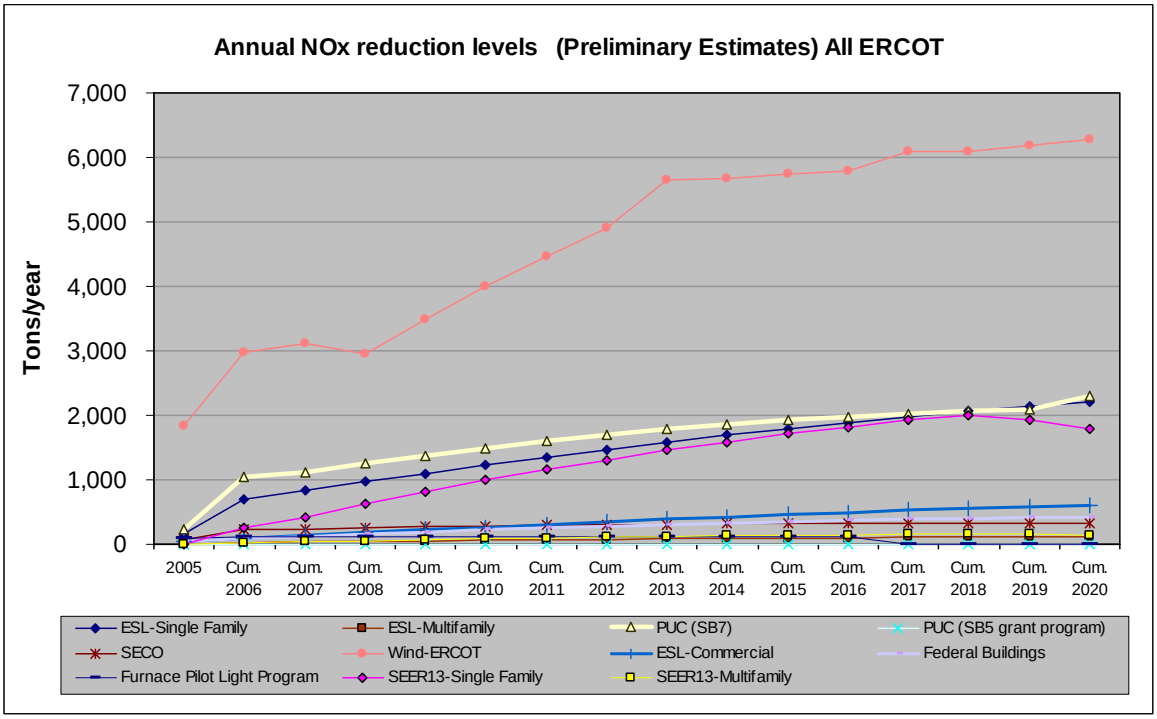


Figure 9-3: Cumulative OSD NOx Emissions Reduction Projections through 2020.

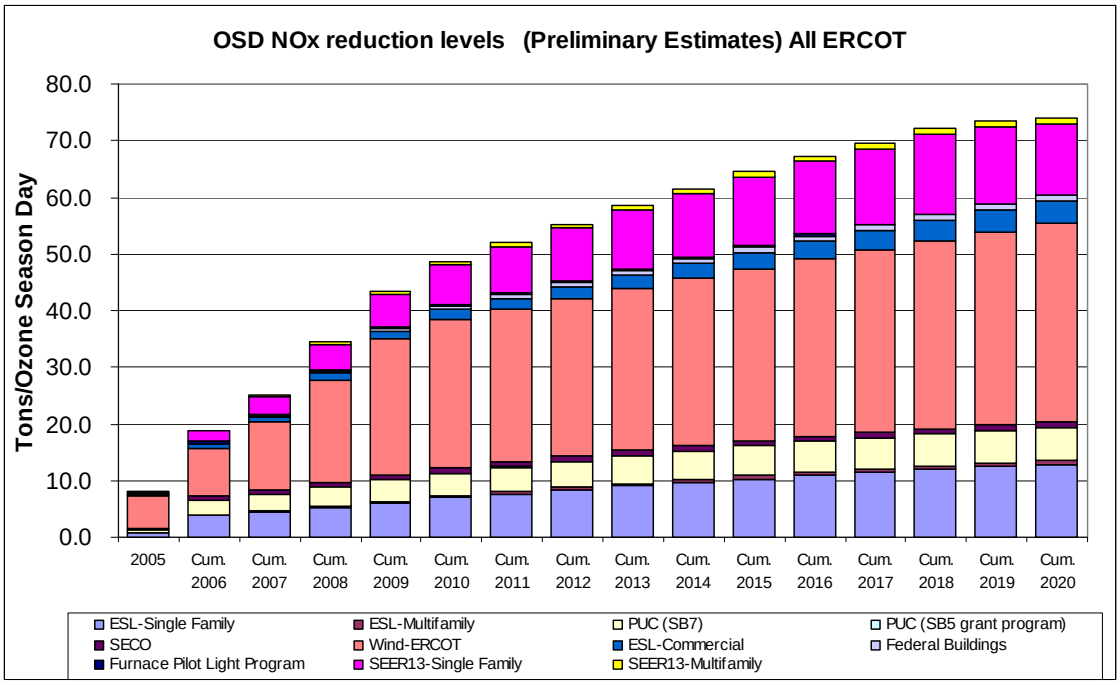


Figure 9-4: Cumulative OSD NOx Emissions Reduction Projections through 2020.

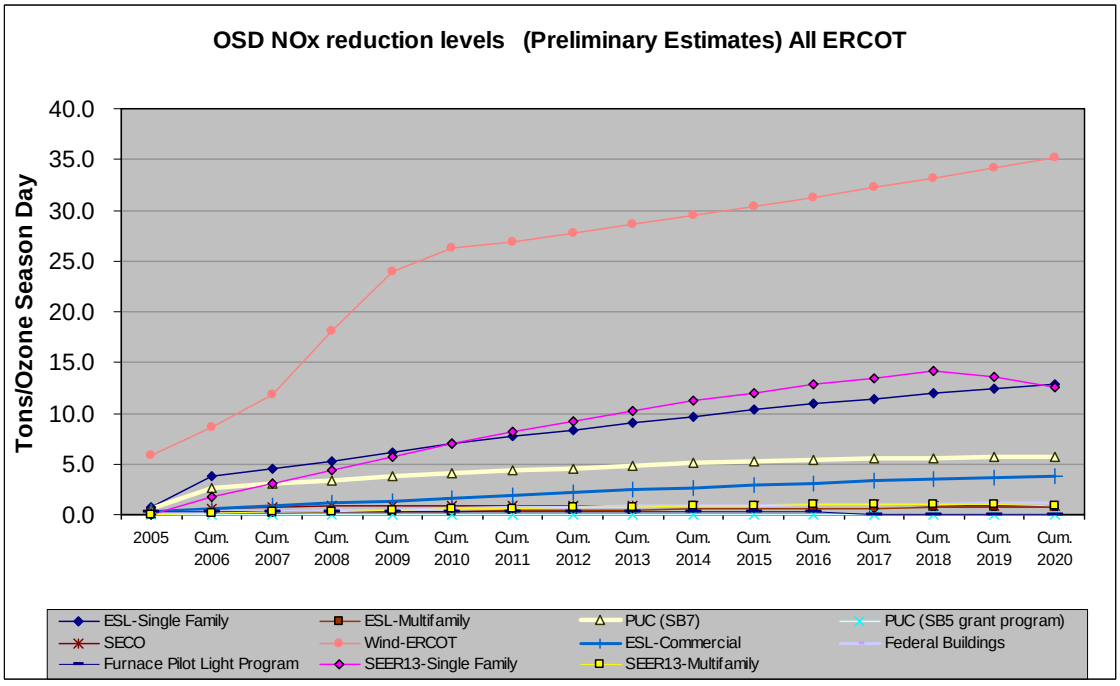


Figure 9-5: Cumulative OSD NOx Emissions Reduction Projections through 2020.

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11 APPENDIX A

11.1 Review of material presented to the TCEQ during 2007/2008 period.

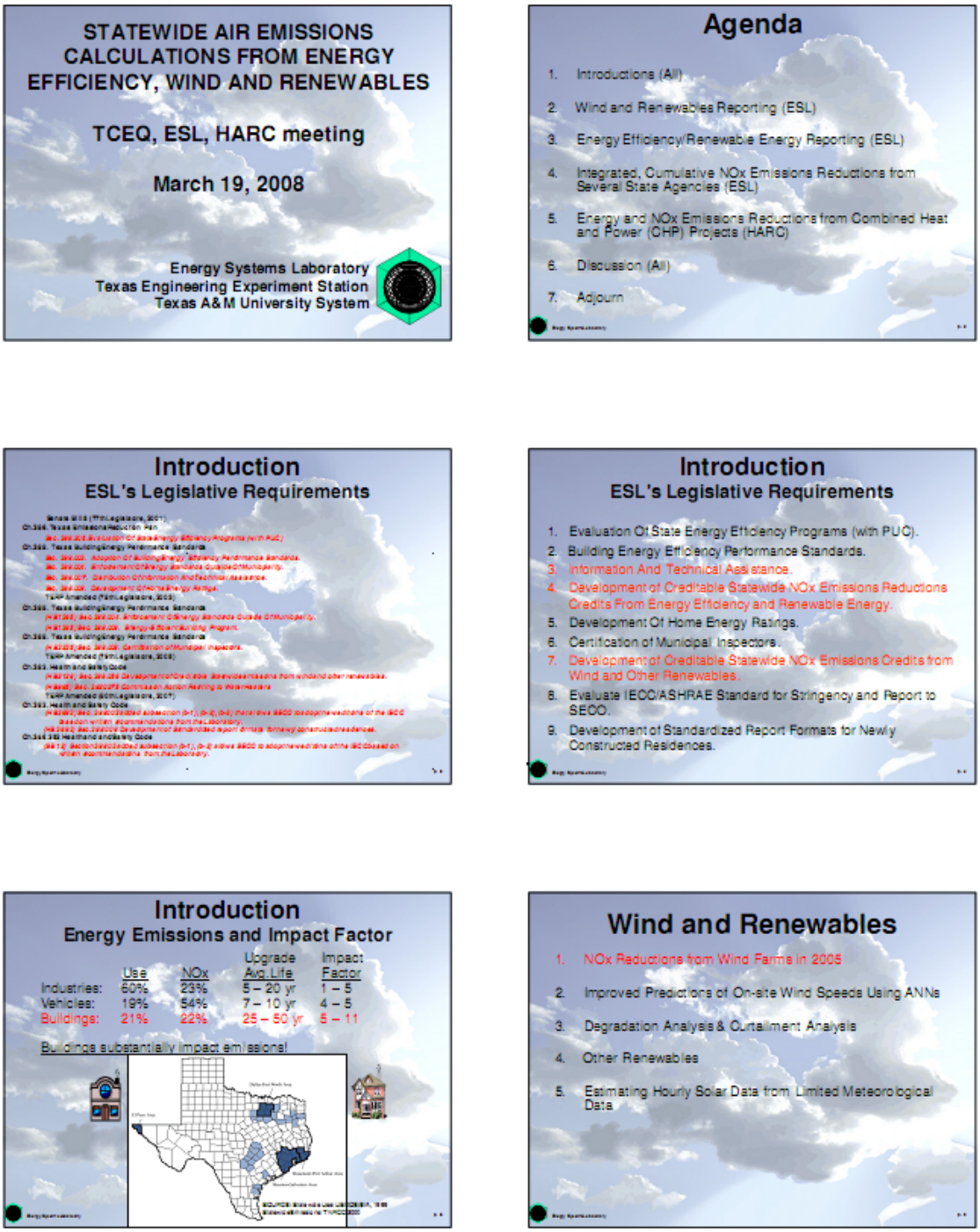
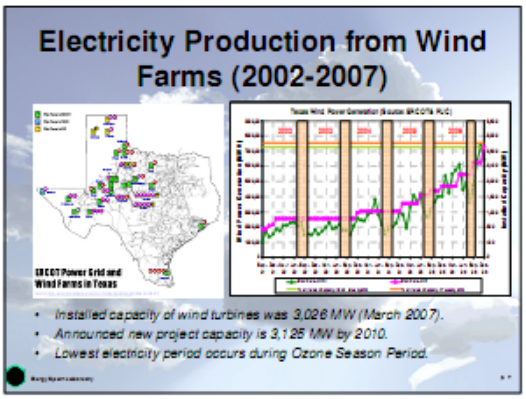
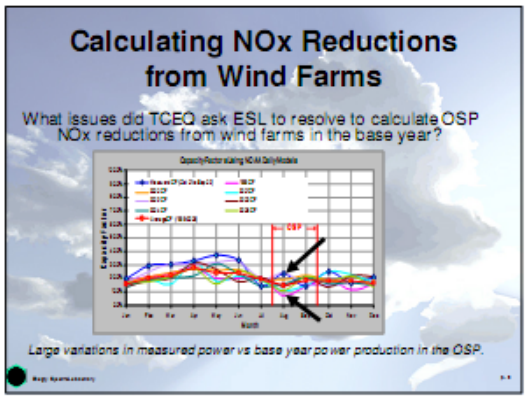
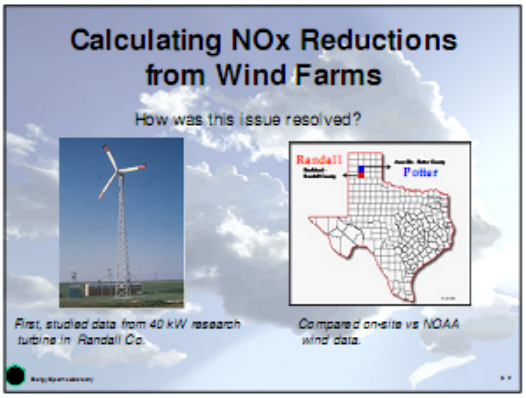
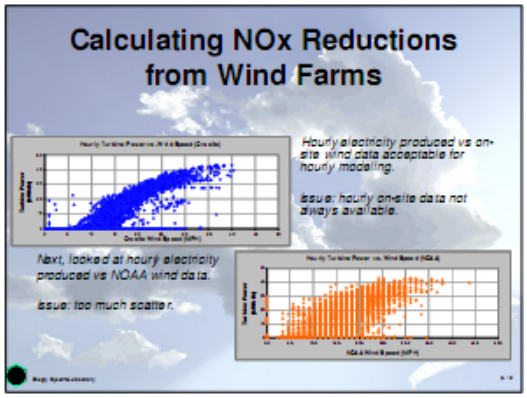


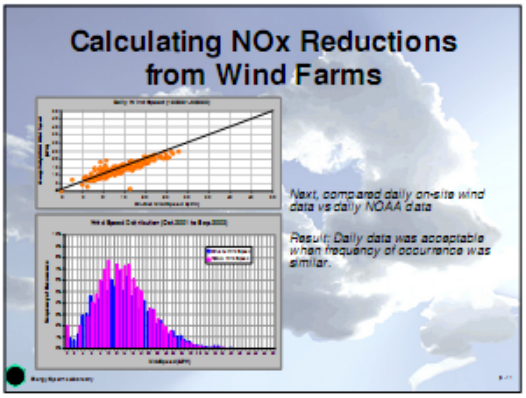
Figure 11-1: Slides Presented to the TECQ in March 2008 (Part 1).











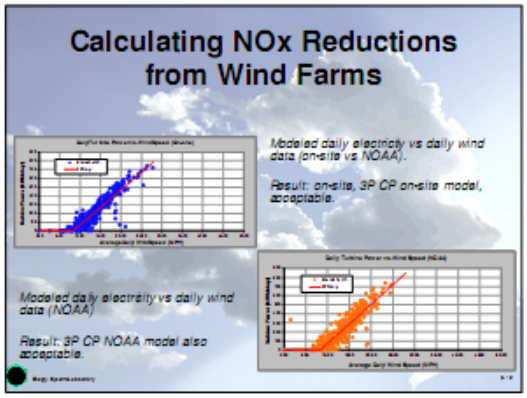
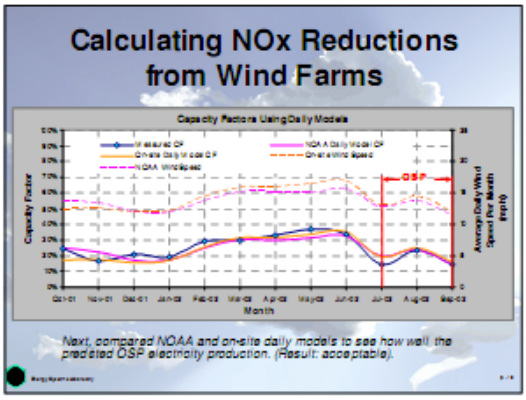
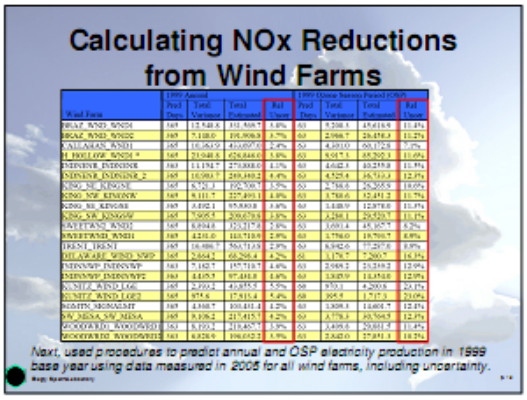
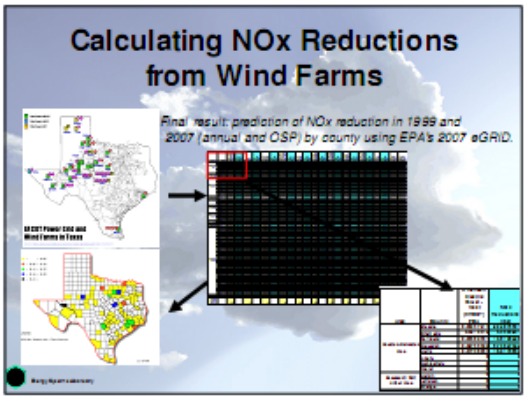
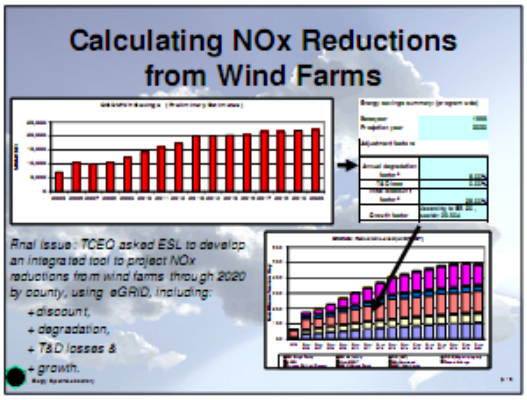


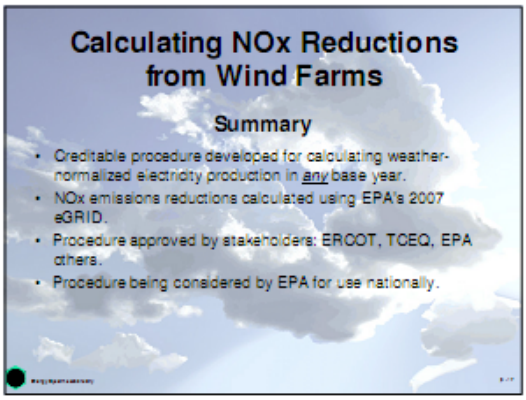
Figure 11-2: Slides Presented to the TECQ in March 2008 (Part 2).











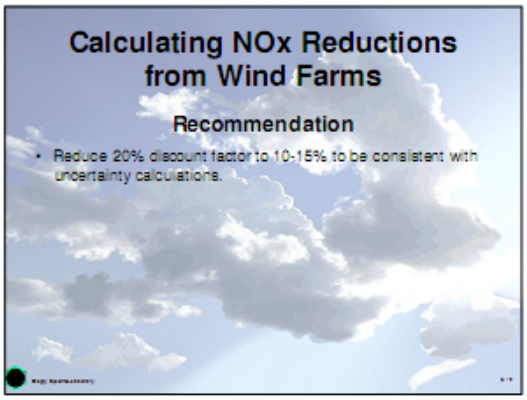
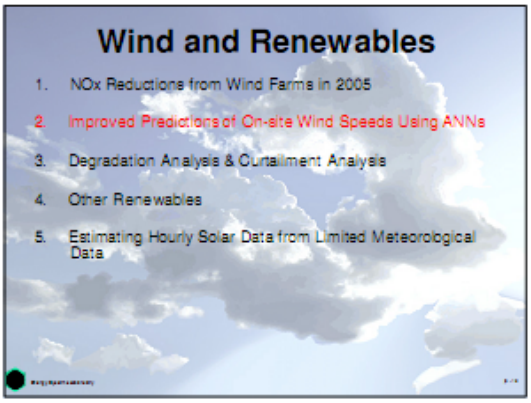
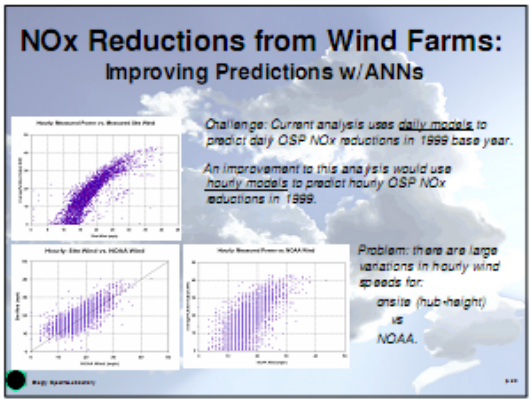
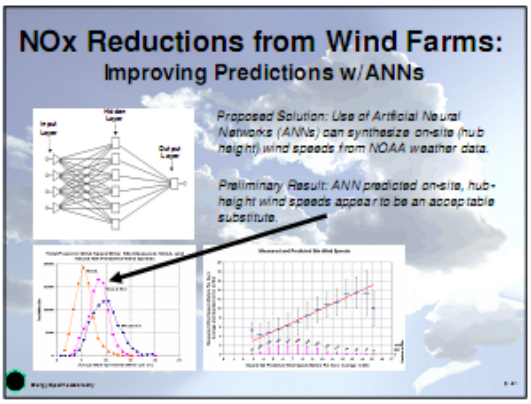
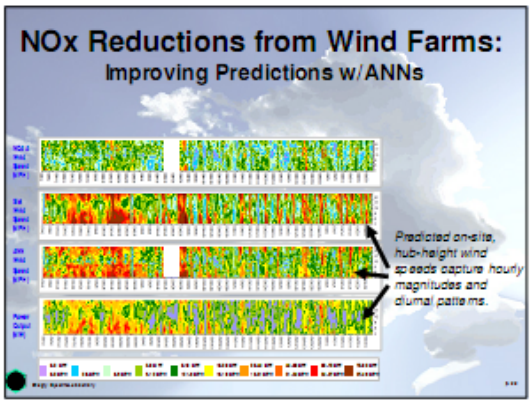


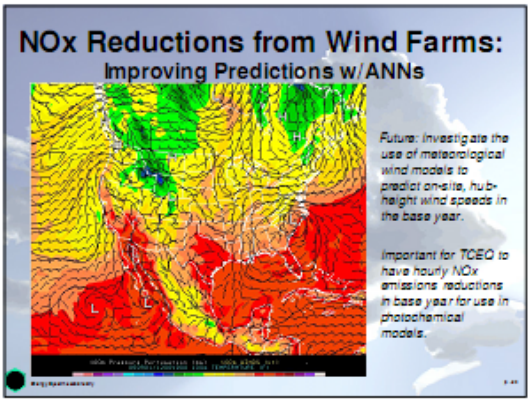
Figure 11-3: Slides Presented to the TECQ in March 2008 (Part 3).











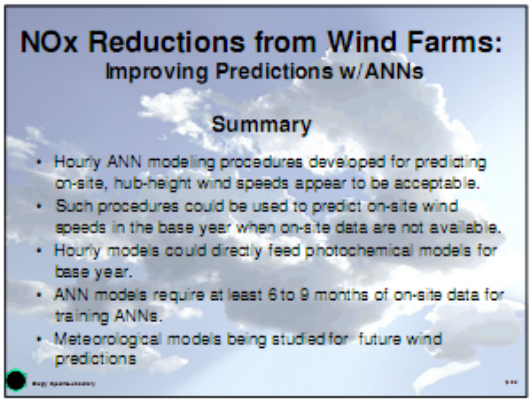
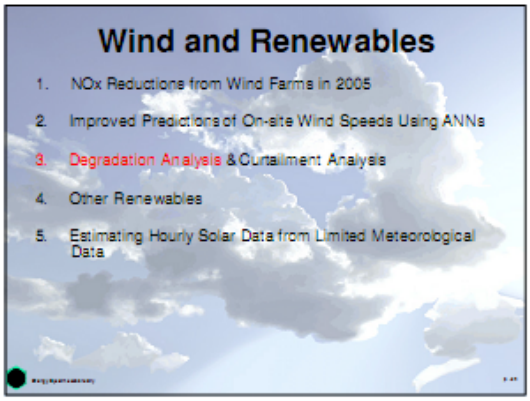
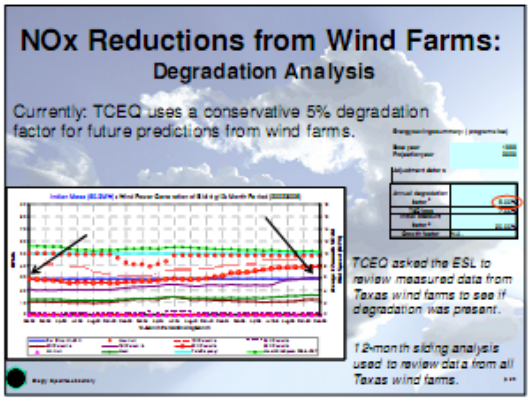
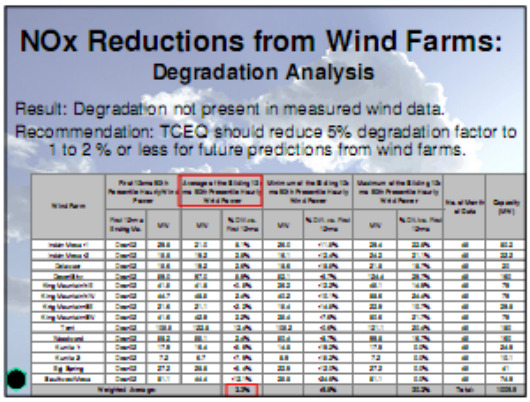
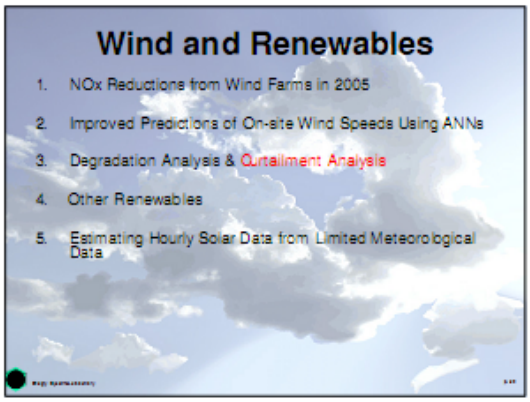


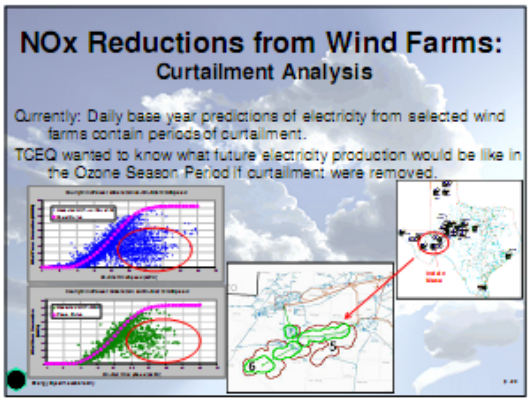
Figure 11-4: Slides Presented to the TECQ in March 2008 (Part 4).











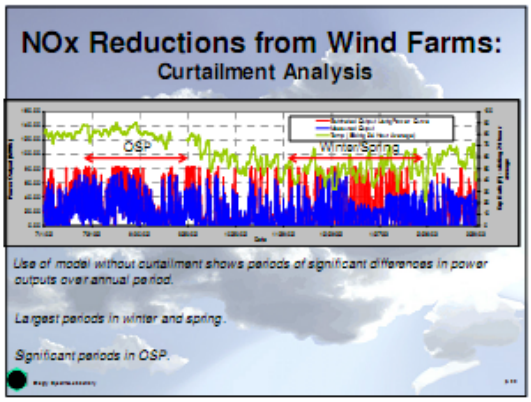
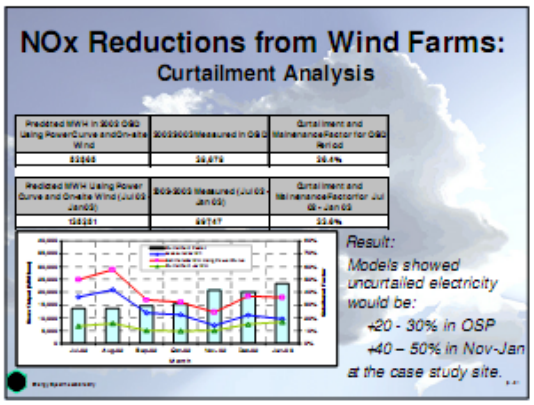
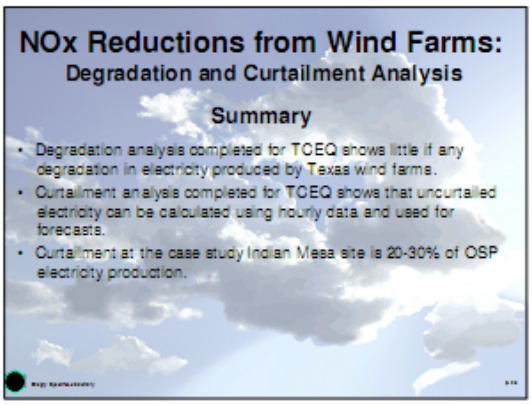
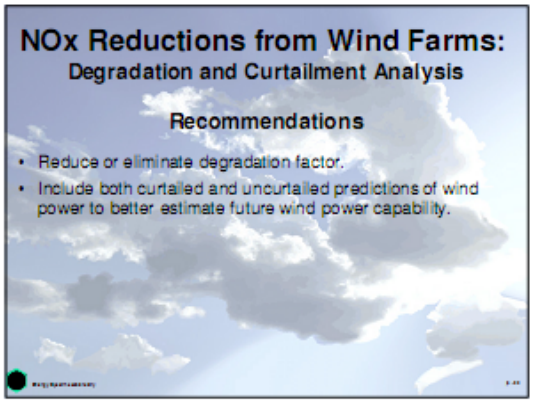
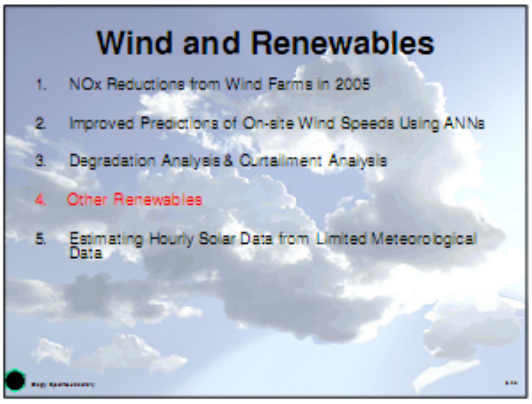


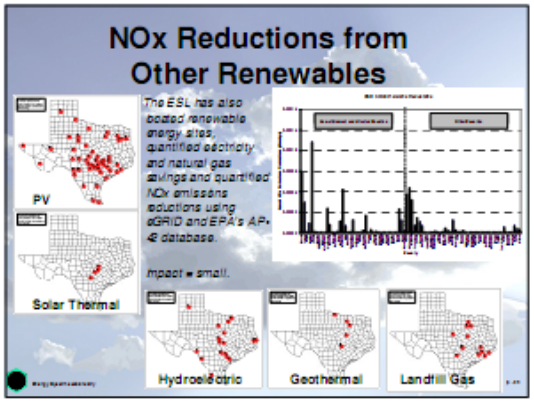
Figure 11-5: Slides Presented to the TECQ in March 2008 (Part 5).











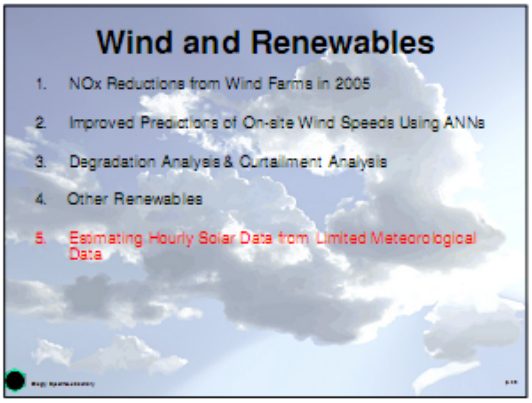
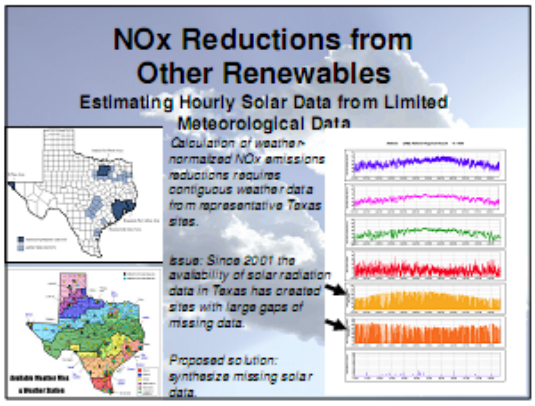
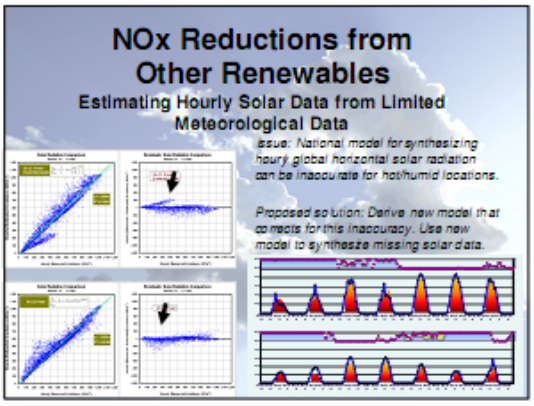
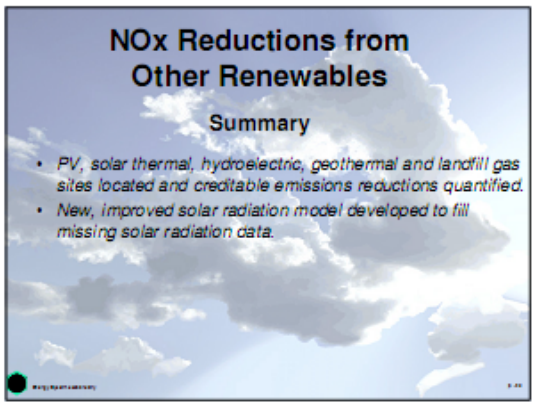
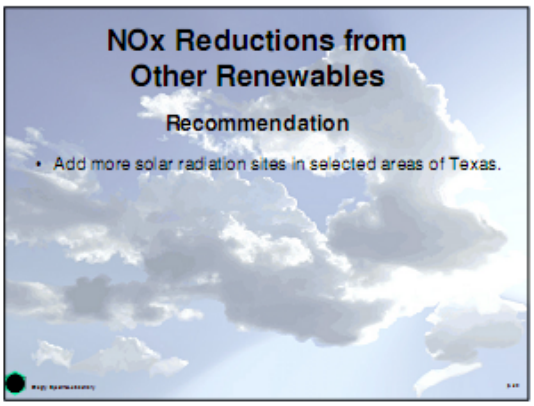


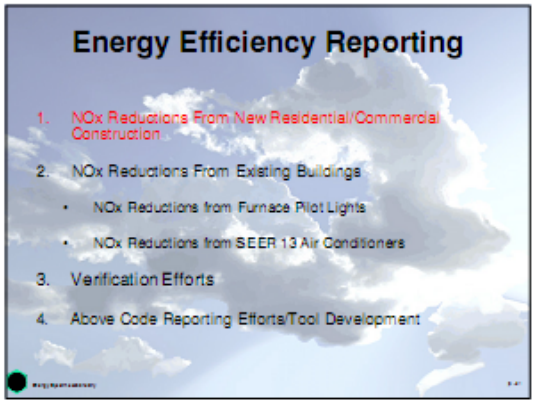
Figure 11-6: Slides Presented to the TECQ in March 2008 (Part 6).











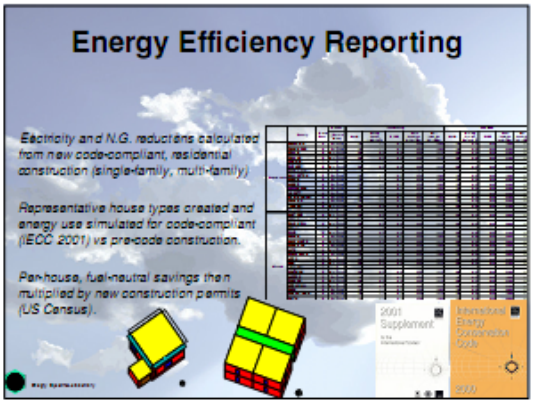


Figure 11-7: Slides Presented to the TECQ in March 2008 (Part 7).

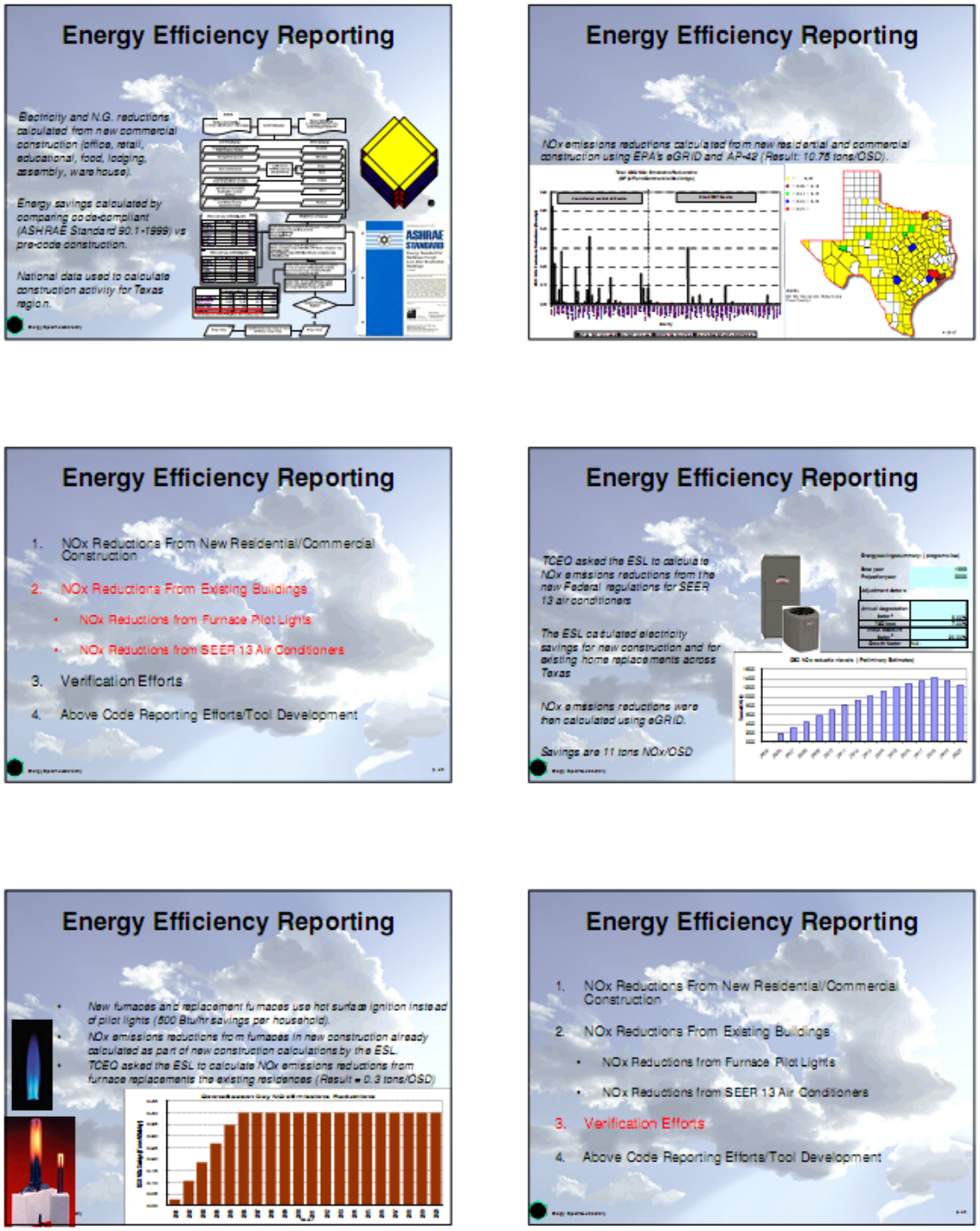


Figure 11-8: Slides Presented to the TECQ in March 2008 (Part 8).

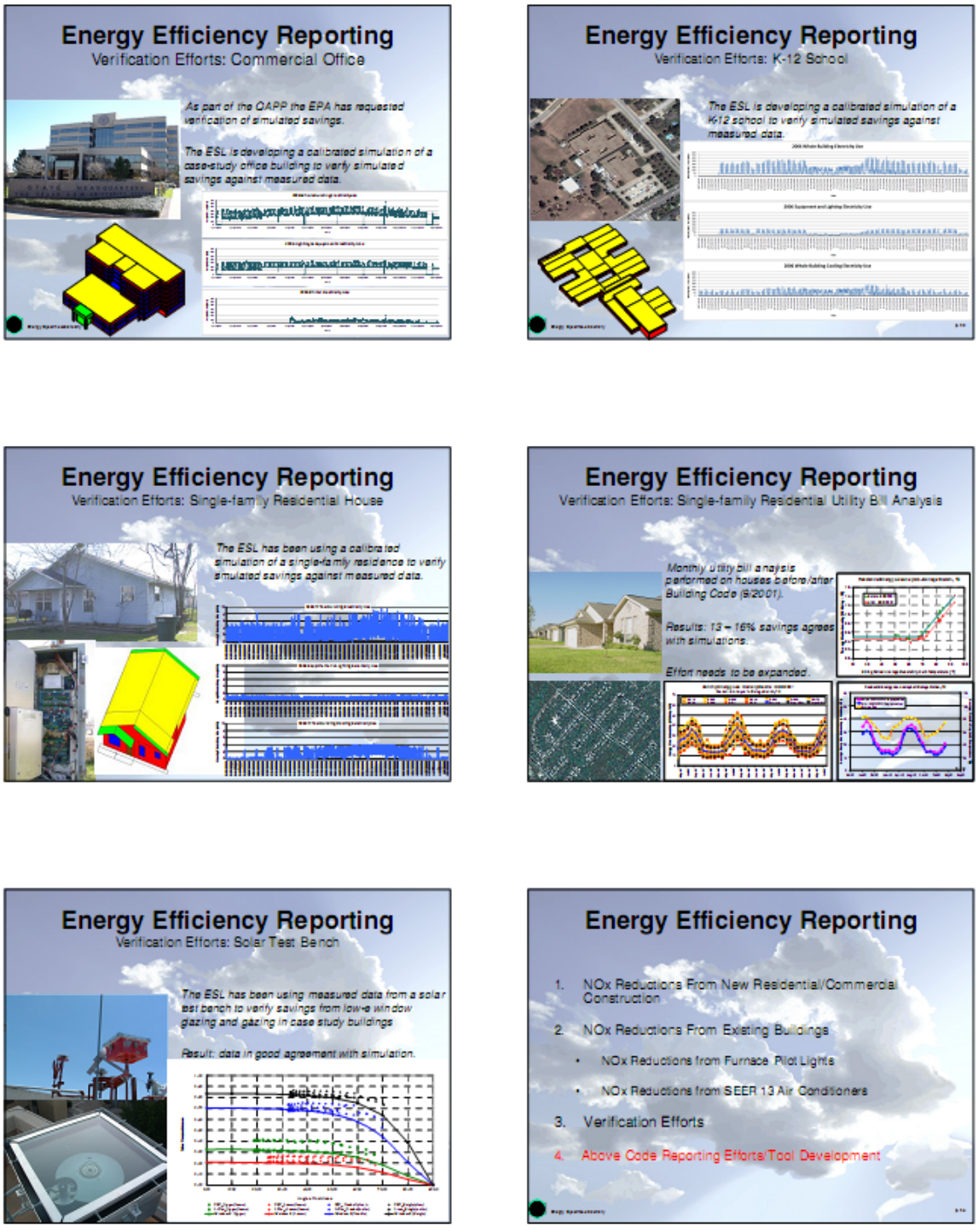
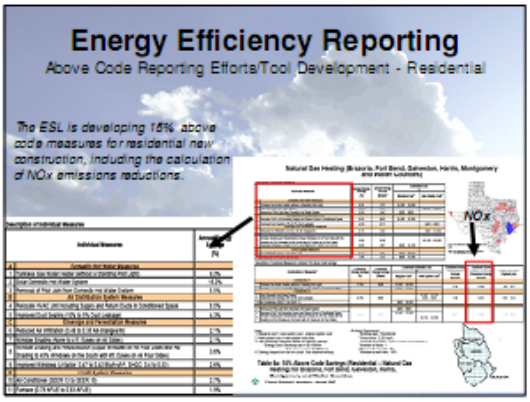
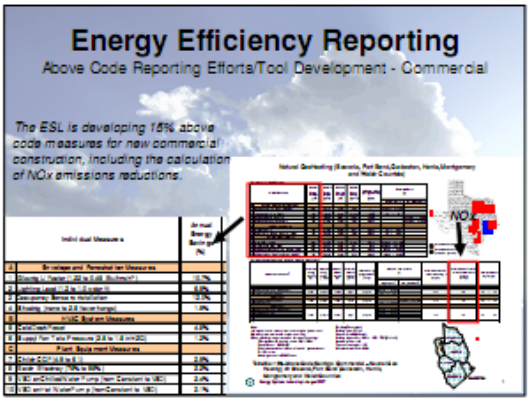
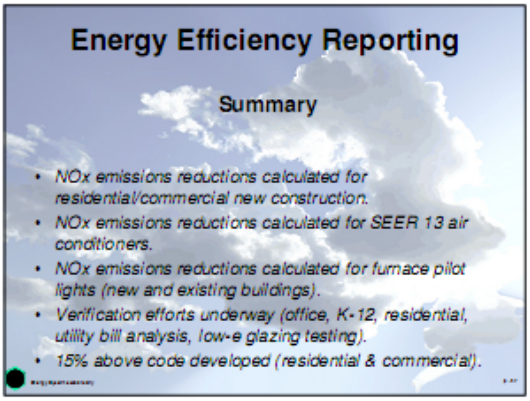
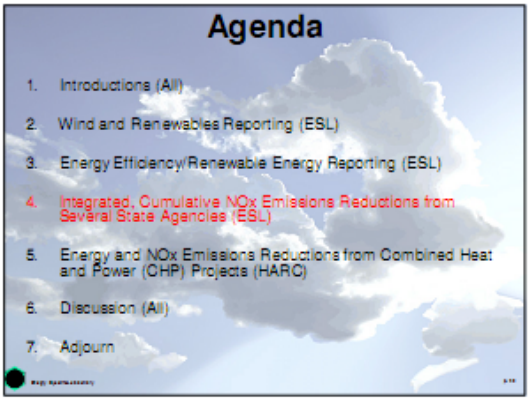


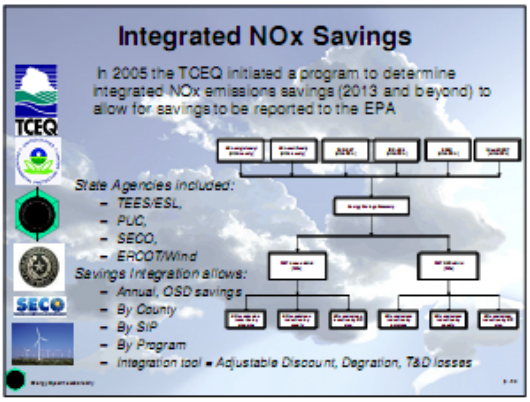
Figure 11-9: Slides Presented to the TECQ in March 2008 (Part 9).











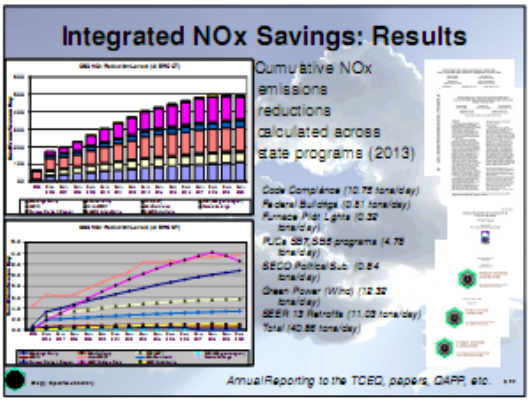
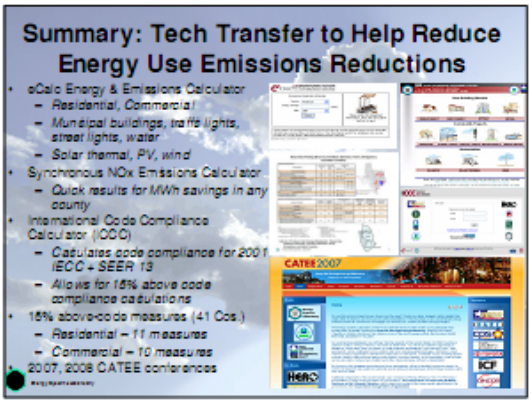
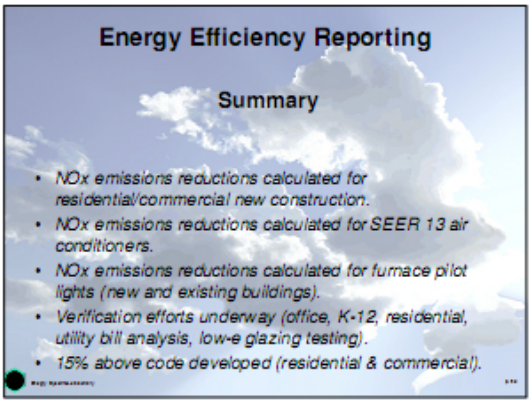
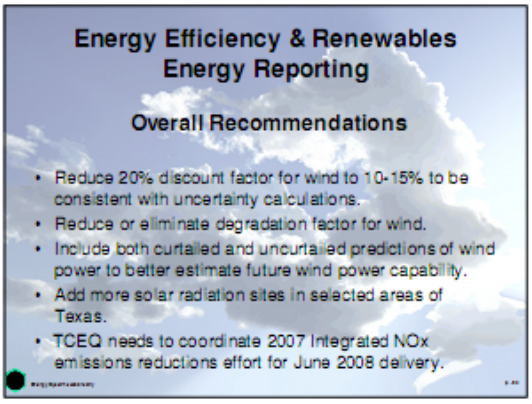


Figure 11-10: Slides Presented to the TECQ in March 2008 (Part 10).







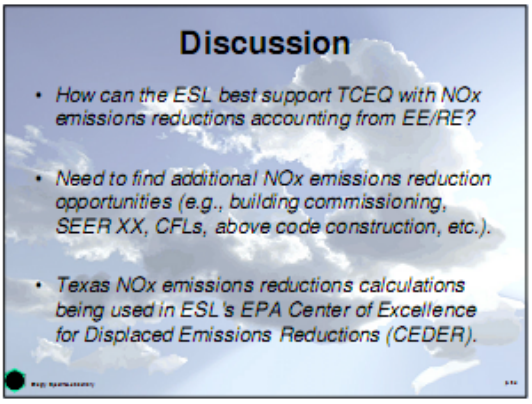


Figure 11-11: Slides Presented to the TECQ in March 2008 (Part 11).

12 APPENDIX B

In this section, the linear regression models developed based on 2006 wind power generation data are presented for each wind farm. The estimated 1999 annual and OSP power production using 2006 daily models and the resulting emissions reduction are also shown in details for each wind farm. A listing of the wind farms analyzed in this year's report is contained in Table 12-1.

Brazos Wind Ranch
Buffalo Gap 1
Callahan Divide Wind Energy Center
Horse Hollow 1
Horse Hollow 2
Horse Hollow 3
Horse Hollow 4
Desert Sky
King Mountain Wind Ranch (KING_NE)
King Mountain Wind Ranch (KING_NW)
King Mountain Wind Ranch (KING_SE)
King Mountain Wind Ranch (KING_SW)
Sweetwater Wind 2
Sweetwater Wind 3
Sweetwater Wind 4
Trent Mesa
Delaware Mountain Wind Farm
Indian Mesa I
Texas Wind Power Project
Big Spring Wind Power
Southwest Mesa Wind Project
Woodward Mountain Ranch (WOODWRD1)
Woodward Mountain Ranch (WOODWRD2)

Table 12-1: Listing of Wind Farms Analyzed for Base-year Calculations.

12.1 Brazos Wind Ranch

Table 12-2: Site Information for Brazos Wind Ranch.

GENSITECODE_ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Interconnection	Weather Station
BRAZ_WIND	WIND	Fluvana	SCURRY	Dec-03	160	Cielo/Orion/Green Mountain	Brazos Wind Ranch	Mitsubishi 1000 (160)	ERCOT	AEP-West	ONCOR	ABI

SUBGENCODE_ERCOT	GENSITECODE_ERCOT	Capacity (MW)
BRAZ_WND_WND1	BRAZ_WIND	99
BRAZ_WND_WND2	BRAZ_WIND	61

Note:
The input power data from 03/01/2006 to 06/11/2006 are excluded from modeling because of errors in those three months.

12.1.1 Brazos Wind Ranch – BRAZ_WND_WND1

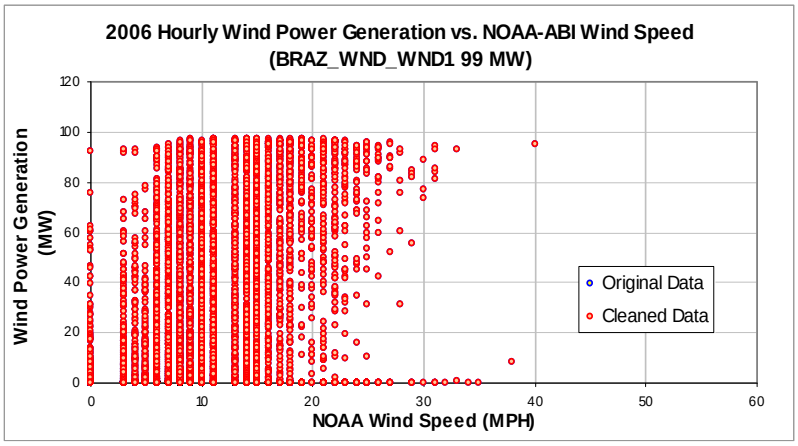


Figure 12-1: BRAZ_WND_WND1 - Hourly Wind Power vs. NOAA Wind Speed (2006).

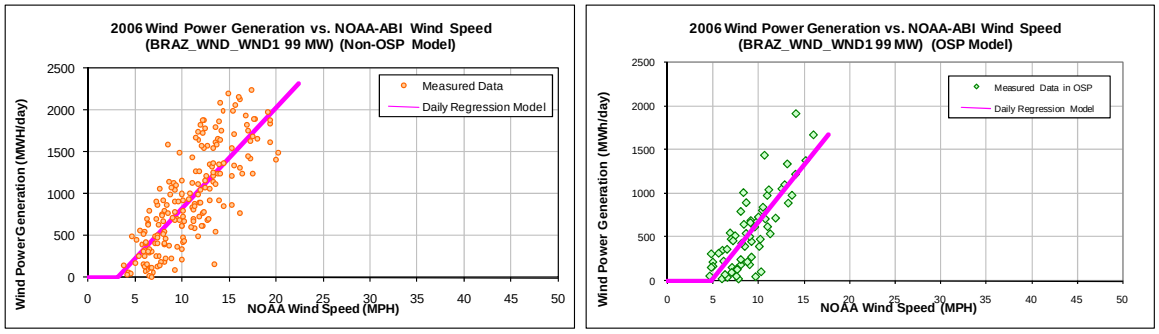


Figure 12-2: BRAZ_WND_WND1 - Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non OSP Model).

Table 12-3: BRAZ_WND_WND1 – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-383.0478
Left Slope (MWh/mph-day)	120.6838
RMSE (MWh/day)	356.7179
R2	0.6244
CV-RMSE	38.2%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-620.4942
Left Slope (MWh/mph-day)	129.5065
RMSE (MWh/day)	262.9682
R2	0.6347
CV-RMSE	46.5%

Table 12-4: BRAZ_WND_WND1 – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	31	11.88	35,672	32,574	8.69%	48%	44%
Feb-06	28	11.14	25,225	26,914	-6.70%	38%	40%
Mar-06	0	N/A	N/A	N/A	N/A	N/A	N/A
Apr-06	0	N/A	N/A	N/A	N/A	N/A	N/A
May-06	0	N/A	N/A	N/A	N/A	N/A	N/A
Jun-06	19	10.22	14,016	16,148	-15.21%	31%	36%
Jul-06	31	10.15	22,262	23,593	-5.98%	30%	32%
Aug-06	31	9.16	15,047	17,521	-16.44%	20%	24%
Sep-06	30	9.46	22,205	20,262	8.75%	31%	28%
Oct-06	31	10.68	28,302	28,100	0.71%	38%	38%
Nov-06	29	10.95	28,818	27,203	5.60%	42%	39%
Dec-06	29	10.68	27,047	26,285	2.82%	39%	38%
Total	259	10.48	218,593	218,600	0.00%	36%	36%
Total in OSP (07/15-09/15)	63	9.16	35,634	35,640	-0.02%	24%	24%

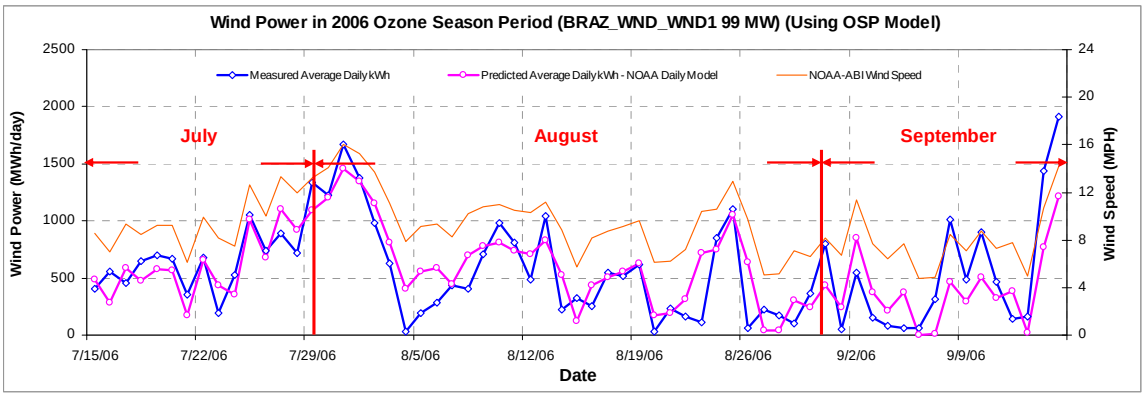


Figure 12-3: BRAZ_WND_WND1 - Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

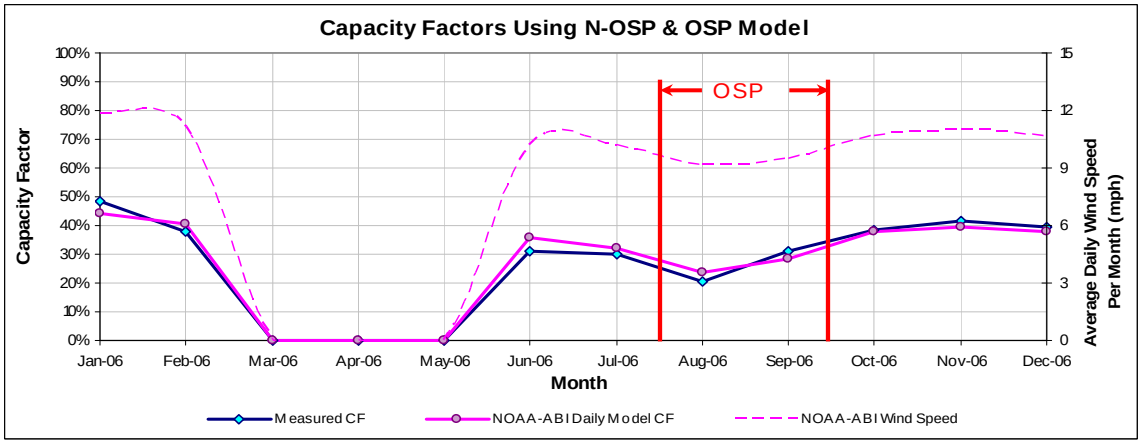


Figure 12-4: BRAZ_WND_WND1 – Predicted Capacity Factors Using Daily Models (2006).

Table 12-5: BRAZ_WND_WND1 – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	**2006 Measured MWh/yr**	**1999 OSD Estimated MWh/day (2006 Daily Model)**	**2006 OSD Measured MWh/day**
348,113	**308,056**	**637**	**566**

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.1.2 Brazos Wind Ranch – BRAZ_WND_WND2.

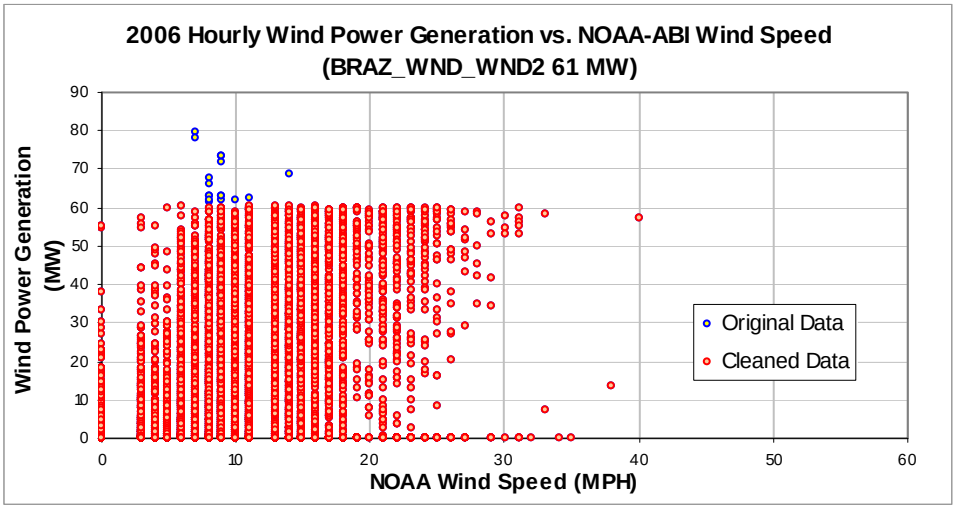


Figure 12-5: BRAZ_WND_WND2 - Hourly Wind Power vs. NOAA Wind Speed (2006).

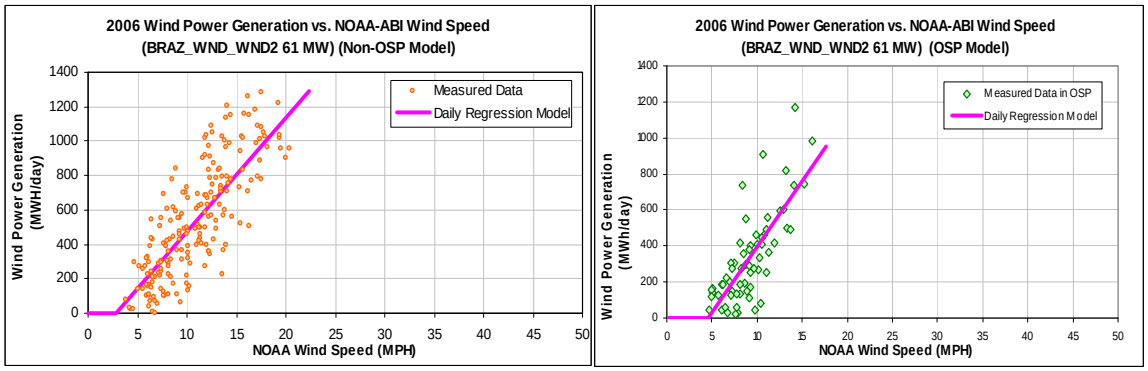


Figure 12-6: BRAZ_WND_WND2 – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-6: BRAZ_WND_WND2 – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-189.8413
Left Slope (MWh/mph-day)	62.2843
RMSE (MWh/day)	194.9943
R2	0.6116
CV-RMSE	37.8%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-337.2185
Left Slope (MWh/mph-day)	72.9199
RMSE (MWh/day)	161.7532
R2	0.5928
CV-RMSE	48.9%

Table 12-7: BRAZ_WND_WND2 – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	31	11.88	19,901	18,528	6.90%	44%	41%
Feb-06	28	11.14	14,667	15,358	-4.71%	36%	37%
Mar-06	0	N/A	N/A	N/A	N/A	N/A	N/A
Apr-06	0	N/A	N/A	N/A	N/A	N/A	N/A
May-06	0	N/A	N/A	N/A	N/A	N/A	N/A
Jun-06	19	10.22	8,781	9,260	-5.45%	32%	33%
Jul-06	31	10.15	12,656	13,619	-7.61%	28%	30%
Aug-06	31	9.16	8,566	10,242	-19.57%	19%	23%
Sep-06	29	9.27	12,245	10,893	11.04%	29%	26%
Oct-06	31	10.68	16,600	16,070	3.19%	37%	35%
Nov-06	29	10.95	17,246	15,537	9.91%	41%	37%
Dec-06	29	10.68	15,511	15,033	3.08%	37%	35%
Total	258	10.47	126,174	124,539	1.30%	33%	33%
Total in OSP (07/15-09/15)	63	9.16	20,830	20,830	0.00%	23%	23%

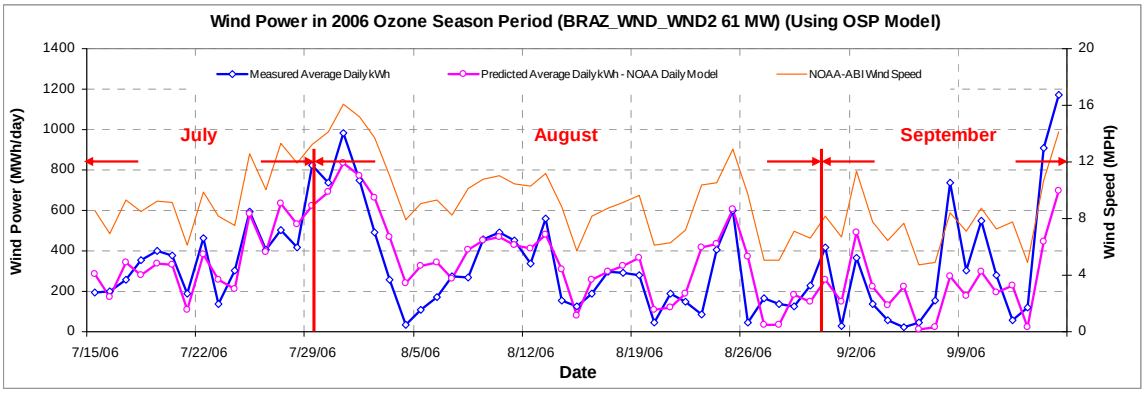


Figure 12-7: BRAZ_WND_WND2 – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

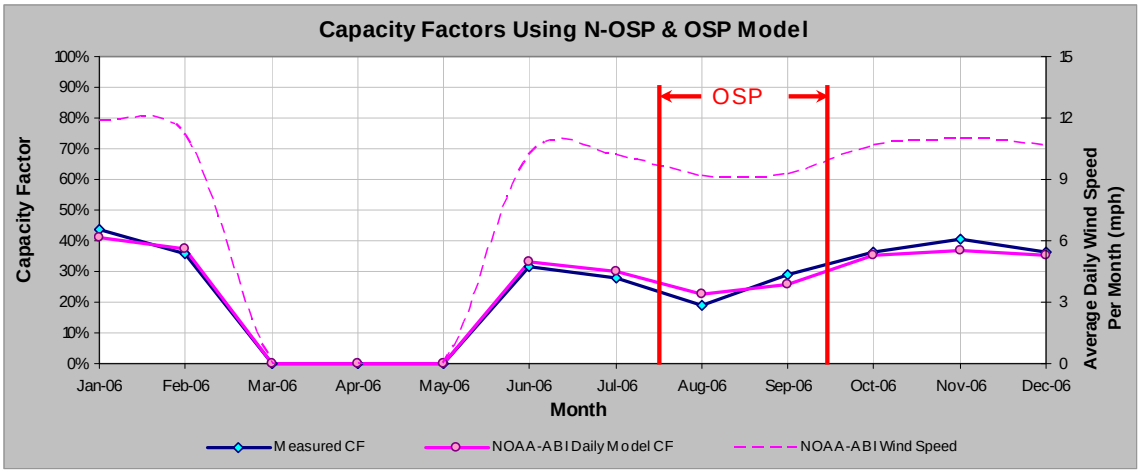


Figure 12-8: BRAZ_WND_WND2 – Predicted Capacity Factors Using Daily Models (2006).

Table 12-8: BRAZ_WND_WND2 – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	**2006 Measured MWh/yr**	**1999 OSD Estimated MWh/day (2006 Daily Model)**	**2006 OSD Measured MWh/day**
198,702	**178,502**	**371**	**331**

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.2 Buffalo Gap 1- BUFF_GAP_UNIT1 120 MW)

Table 12-9: Site Information for Buffalo Gap 1.

GENSITECODE_ ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Interconnection	Weather Station
BUFF_CAP	WIND	Abilene	TAYLOR	Sep-05	120	AES Corporation	Buffalo Gap1	Vestas 1.8 MW (67)	ERCOT	AEP-West	AEP-TNC	ABI

SUBGENCODE_ERCOT	GENSITECODE_ ERCOT	Capacity (MW)
BUFF_GAP_UNIT1	BUFF_CAP	120

12.2.1 Buffalo Gap 1 – BUFF_GAP_UNIT1 120 MW)

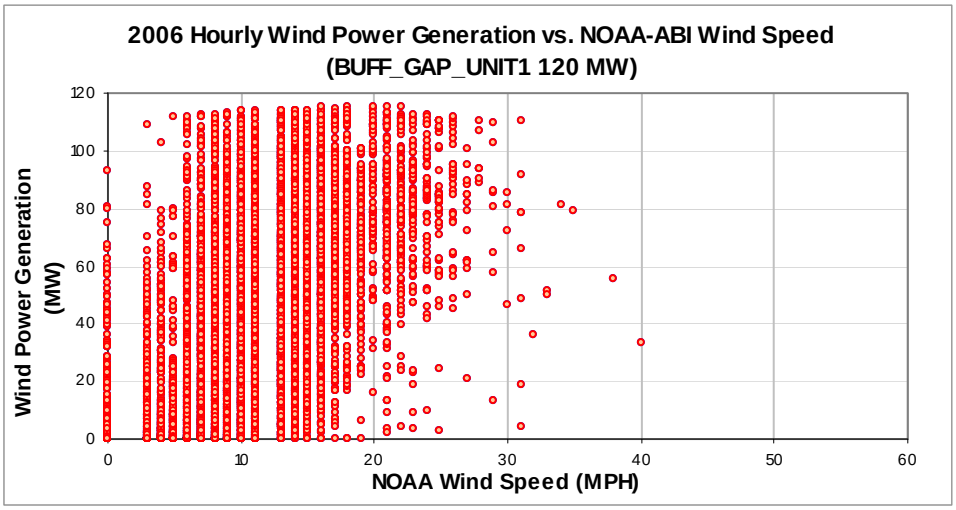


Figure 12-9: BUFF_GAP_UNIT1 – Hourly Wind Power vs. NOAA Wind Speed (2006).

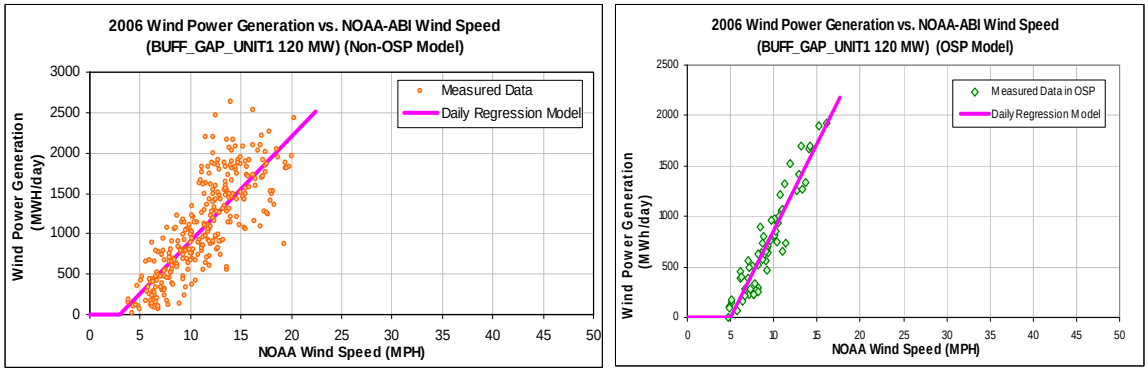


Figure 12-10: BUFF_GAP_UNIT1 – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-10: BUFF_GAP_UNIT1 – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-383.2955
Left Slope (MWh/mph-day)	129.6069
RMSE (MWh/day)	351.6707
R2	0.6519
CV-RMSE	32.5%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-844.9386
Left Slope (MWh/mph-day)	170.7604
RMSE (MWh/day)	164.8432
R2	0.8849
CV-RMSE	22.9%

Table 12-11: BUFF_GAP_UNIT1 – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	31	11.88	29,613	35,852	-21.07%	33%	40%
Feb-06	28	11.14	29,078	29,690	-2.11%	36%	37%
Mar-06	31	12.60	33,929	38,742	-14.19%	38%	43%
Apr-06	30	12.27	33,323	36,212	-8.67%	39%	42%
May-06	31	12.32	37,770	37,610	0.42%	42%	42%
Jun-06	30	9.83	23,099	26,706	-15.61%	27%	31%
Jul-06	31	10.15	27,947	28,228	-1.01%	31%	32%
Aug-06	31	9.16	22,102	22,271	-0.77%	25%	25%
Sep-06	30	9.46	23,209	23,299	-0.39%	27%	27%
Oct-06	31	10.68	35,498	31,048	12.54%	40%	35%
Nov-06	29	10.95	38,512	30,028	22.03%	46%	36%
Dec-06	31	10.81	37,110	31,552	14.98%	42%	35%
Total	364	10.94	371,190	371,239	-0.01%	35%	35%
Total in OSP (07/15-09/15)	63	9.16	45,297	45,346	-0.11%	25%	25%

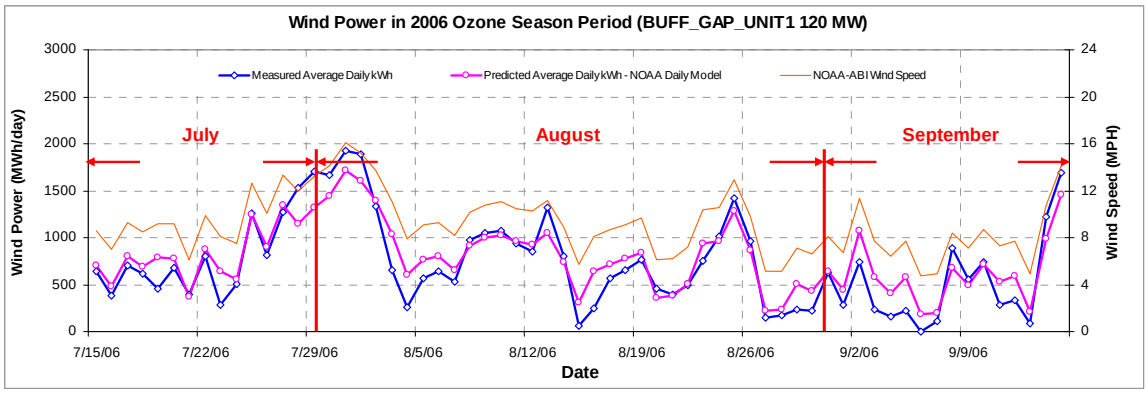


Figure 12-11: BUFF_GAP_UNIT1 – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

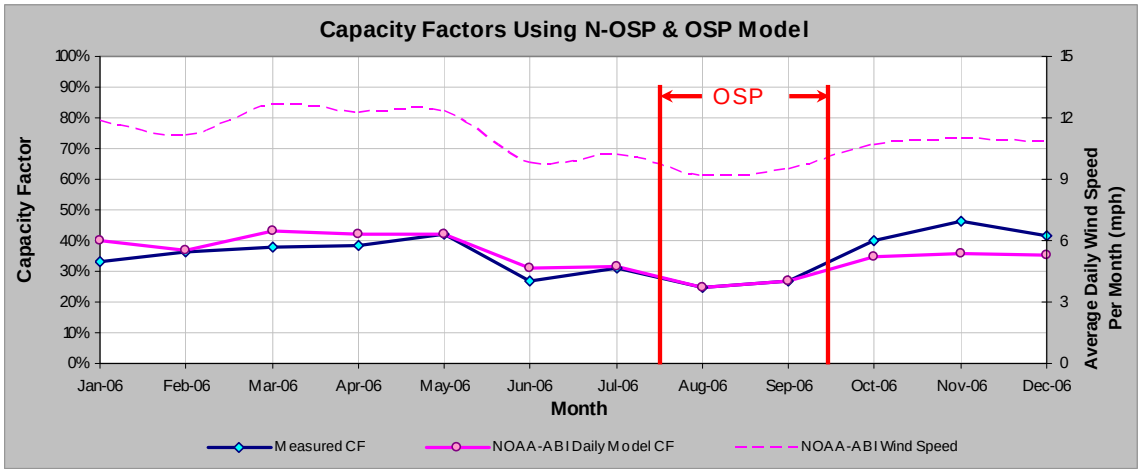


Figure 12-12: BUFF_GAP_UNIT1 – Predicted Capacity Factors Using Daily Models (2006).

Table 12-12: BUFF_GAP_UNIT1 – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	**2006 Measured MWh/yr**	**1999 OSD Estimated MWh/day (2006 Daily Model)**	**2006 OSD Measured MWh/day**
390,430	**372,210**	**813**	**719**

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.3 Callahan Divide Wind Energy Center

Table 12-13: Site Information for Callahan Divide Wind Energy Center.

GENSITECODE_ ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Interconnection	Weather Station
CALLAHAN	WIND	Abilene	TAYLOR	Feb-07	114	FPL Energy	Callahan Divide Wind Energy Center	GE Wind 1500 (76)	ERCOT	AEP-West	AEP-TNC	ABI

SUBGENCODE_ ERCOT	GENSITECODE_ ERCOT	Capacity (MW)
CALLAHAN_WND1	CALLAHAN	114

12.3.1 Callahan Divide – CALLAHAN_WND1

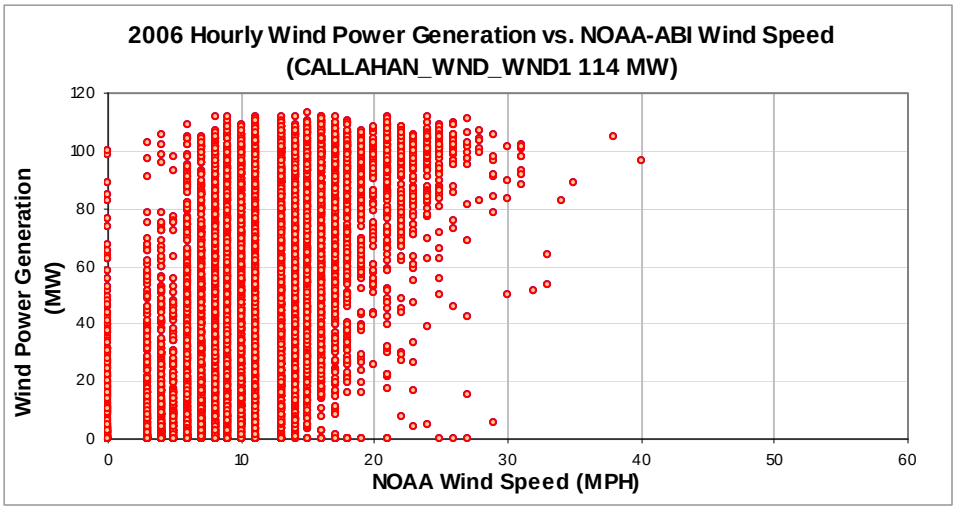


Figure 12-13: CALLAHAN_WND1 – Hourly Wind Power vs. NOAA Wind Speed (2006).

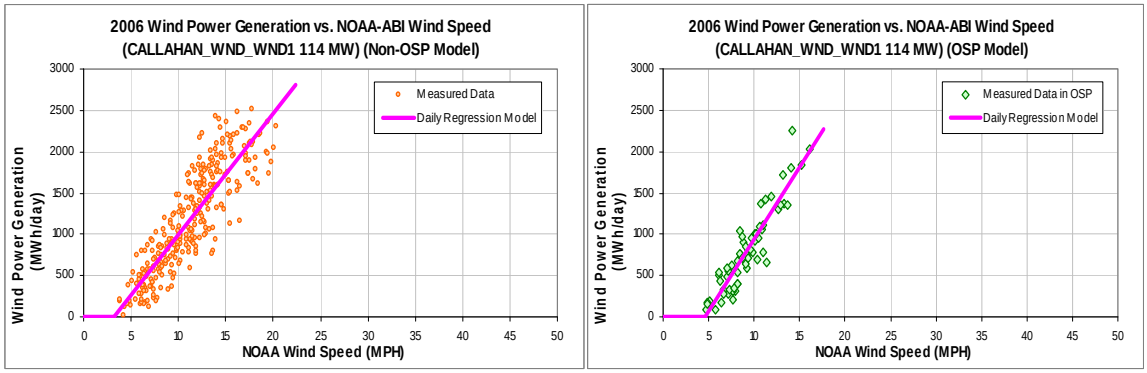


Figure 12-14: CALLAHAN_WND1 – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-14: CALLAHAN_WND1 – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-460.55
Left Slope (MWh/mph-day)	145.94
RMSE (MWh/day)	303.64
R2	0.76
CV-RMSE	26.51%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-799.83
Left Slope (MWh/mph-day)	173.51
RMSE (MWh/day)	193.1
R2	0.8526
CV-RMSE	24.5%

Table 12-15: CALLAHAN_WND1 – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	31	11.88	41416.29	39473.73	4.69%	49%	47%
Feb-06	28	11.14	29501.46	32621.77	-10.58%	39%	43%
Mar-06	31	12.60	36312.30	42727.71	-17.67%	43%	50%
Apr-06	30	12.27	38919.52	39907.69	-2.54%	47%	49%
May-06	31	12.32	41697.41	41453.41	0.59%	49%	49%
Jun-06	30	9.83	28635.07	29203.15	-1.98%	35%	36%
Jul-06	31	10.15	30662.82	30678.75	-0.05%	36%	36%
Aug-06	31	9.16	23754.66	24450.07	-2.93%	28%	29%
Sep-06	30	9.46	26979.01	25795.33	4.39%	33%	31%
Oct-06	31	10.68	34765.74	34063.73	2.02%	41%	40%
Nov-06	29	10.95	39026.32	32973.66	15.51%	49%	42%
Dec-06	31	10.81	36309.65	34631.25	4.62%	43%	41%
Total	364		407980.25	407980.25	0.00%	41%	41%
Total in OSP (07/15-09/15)	63	9.16	49725.13	49725.13	0.00%	29%	29%

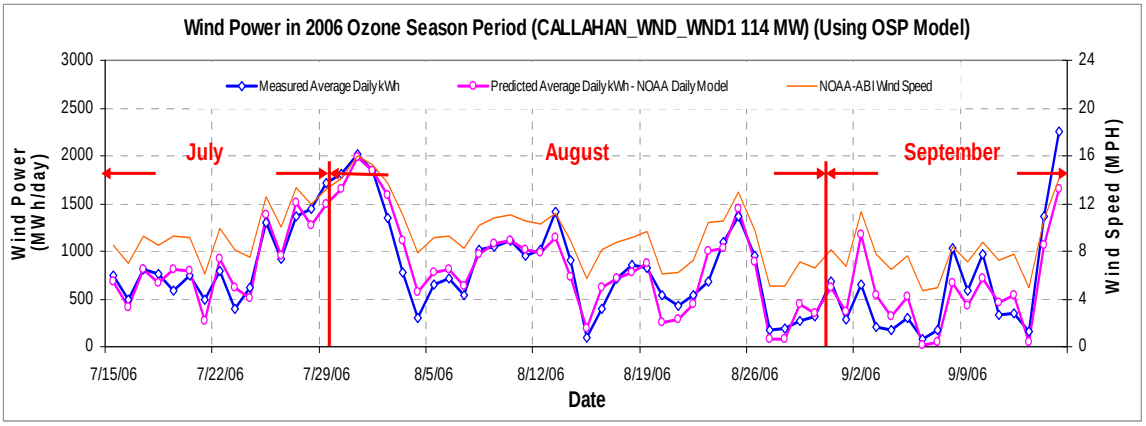


Figure 12-15: CALLAHAN_WND1 – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

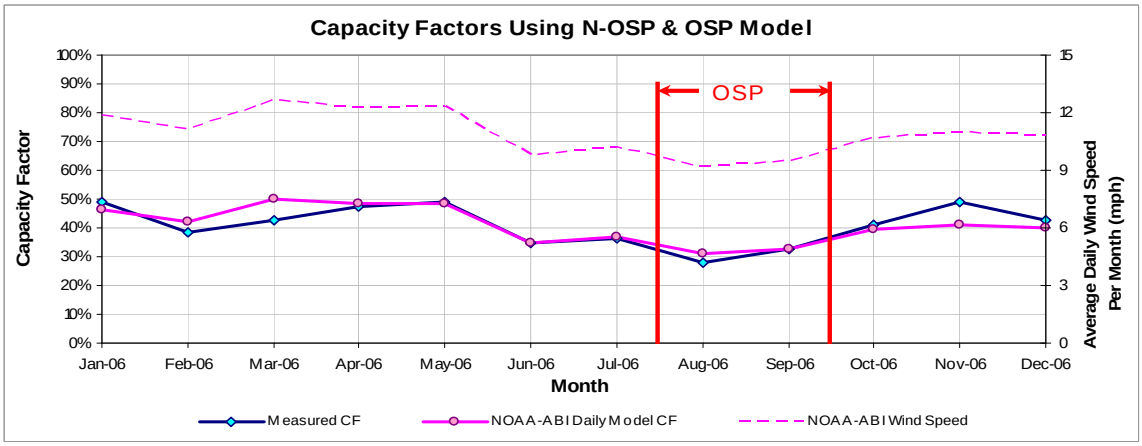


Figure 12-16: CALLAHAN_WND1 – Predicted Capacity Factors Using Daily Models (2006).

Table 12-16: CALLAHAN_WND1 – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	**2006 Measured MWh/yr for Modeling**	**1999 OSD Estimated MWh/day (2006 Daily Model)**	**2006 OSD Measured MWh/day for Modeling**
428,993	**409,101**	**885**	**789**

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.4 Horse Hollow 1

Table 12-17: Site Information for Horse Hollow 1.

GENSITECODE_ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Interconnection	Weather Station	Remarks
H_HOLLOW	WIND	Abilene	TAYLOR	Oct-05	213	FPL Energy	Horse Hollow 1	GE Energy 1.5 MW (142)	ERCOT	AEP-West	AEP-TNC	ABI	

SUBGENCODE_ERCOT	GENSITECODE_ERCOT	Capacity (MW)
H_HOLLOW_WND1	H_HOLLOW	213

12.4.1 Horse Hollow 1 – H_HOLLOW_WND1

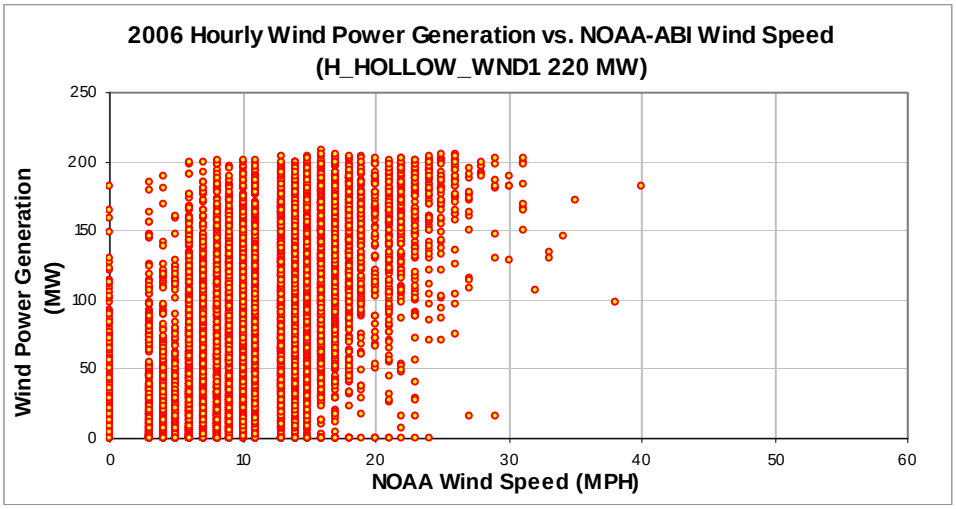


Figure 12-17: H_HOLLOW_WND1 – Hourly Wind Power vs. NOAA Wind Speed (2006).

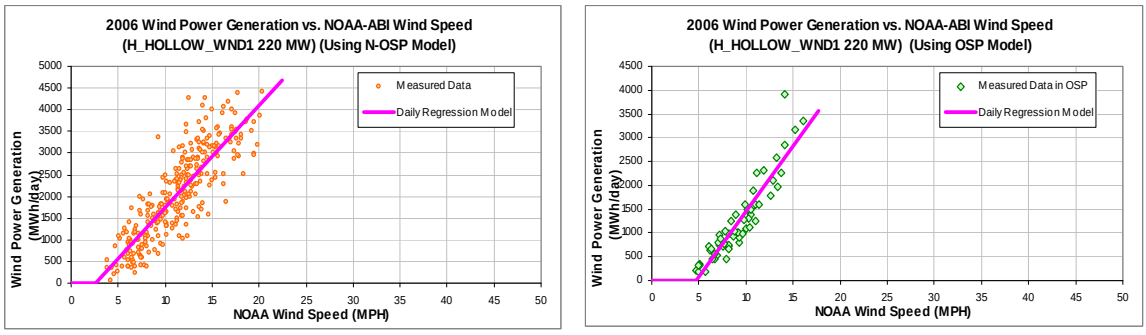


Figure 12-18: H_HOLLOW_WND1 – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-18: H_HOLLOW_WND1 – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-620.45
Left Slope (MWh/mph-day)	236.58
RMSE (MWh/day)	533.46
R2	0.73
CV-RMSE	25.86

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-1305.158
Left Slope (MWh/mph-day)	274.763
RMSE (MWh/day)	299.99
R2	0.857
CV-RMSE	24.8%

Table 12-19: H_HOLLOW_WND1 – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	31	11.88	70,482	67,897	3.67%	43%	41%
Feb-06	28	11.14	55,937	56,412	-0.85%	38%	38%
Mar-06	31	12.60	64,160	73,172	-14.05%	39%	45%
Apr-06	30	12.27	68,890	68,475	0.60%	43%	43%
May-06	31	12.32	71,818	71,107	0.99%	44%	43%
Jun-06	30	9.83	42,241	51,122	-21.03%	27%	32%
Jul-06	31	10.15	44,978	50,215	-11.64%	27%	31%
Aug-06	31	9.16	35,693	37,522	-5.12%	22%	23%
Sep-06	27	9.42	40,548	37,656	7.13%	28%	26%
Oct-06	26	10.76	49,606	50,057	-0.91%	36%	36%
Nov-06	29	10.95	68,606	57,108	16.76%	45%	37%
Dec-06	31	10.81	67,831	60,048	11.47%	41%	37%
Total	356		680,789	680,791	0.00%	36%	36%
Total in OSP (07/15-09/15)	63	9.16	76,312	76,314	0.00%	23%	23%

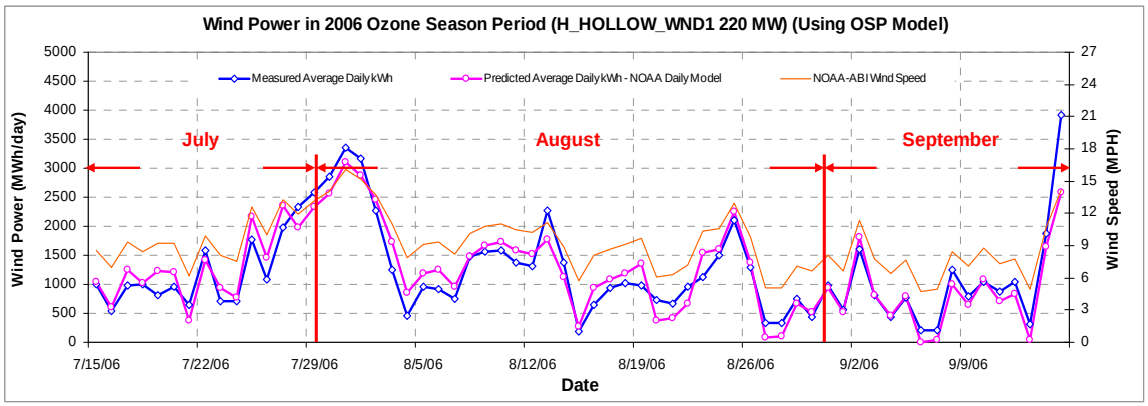


Figure 12-19: H_HOLLOW_WND1 – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

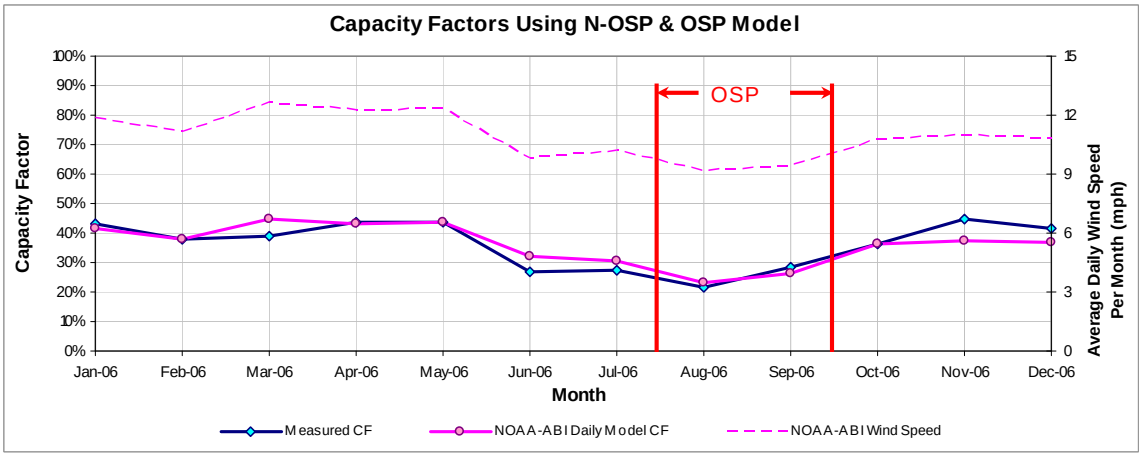


Figure 12-20: H_HOLLOW_WND1 – Predicted Capacity Factors Using Daily Models (2006).

Table 12-20: H_HOLLOW_WND1 – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	**2006 Measured MWh/yr for Modeling**	**1999 OSD Estimated MWh/day (2006 Daily Model)**	**2006 OSD Measured MWh/day for Modeling**
728,851	**698,000**	**1,363**	**1,211**

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.5 Horse Hollow 2

Table 12-21: Site Information for Horse Hollow 2.

GENSITECODE_ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Interconnection	Weather Station
HHOLLOW2_WIND1	WIND	Abilene	Taylor	Jul-06	224	FPL Energy	Horse Hollow Phase 2	Mitsubishi 1000 (160)	ERCOT	AEP-West	AEP/ TNC	ABI

SUBGENCODE_ERCOT	GENSITECODE_ERCOT	Capacity (MW)
HHOLLOW2_WIND1	HHOLLOW2_WIND1	224

12.5.1 Horse Hollow 2 – H_HOLLOW_WND2

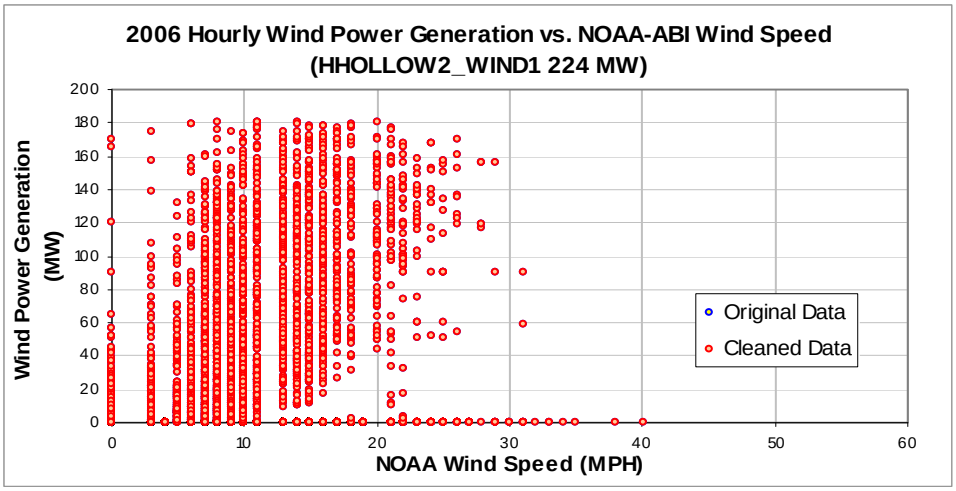


Figure 12-21: H_HOLLOW_WND2 – Hourly Wind Power vs. NOAA Wind Speed (2006).

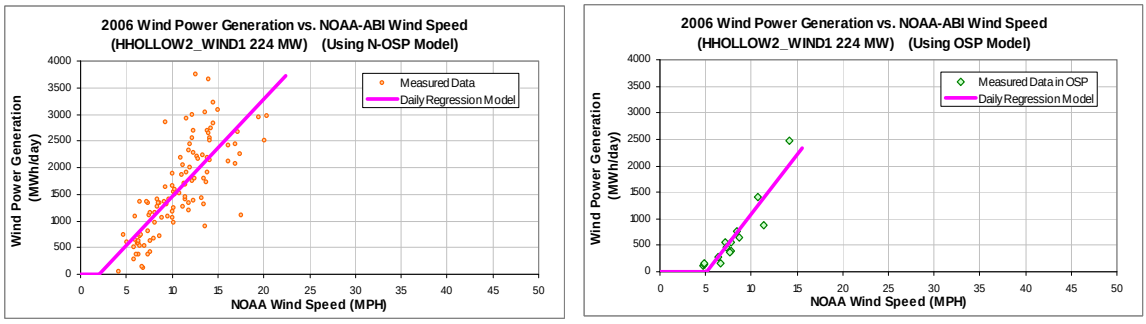


Figure 12-22: H_HOLLOW_WND2 – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-22: H_HOLLOW_WND2 – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-379.61
Left Slope (MWh/mph-day)	183.45
RMSE (MWh/day)	546.01
R2	0.59
CV-RMSE	33.93%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-1134.7710
Left Slope (MWh/mph-day)	222.81
RMSE (MWh/day)	241.003
R2	0.8589
CV-RMSE	38.5%

Table 12-23: H_HOLLOW_WND2 – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	0	N/A	0	0	N/A	N/A	N/A
Feb-06	0	N/A	0	0	N/A	N/A	N/A
Mar-06	0	N/A	0	0	N/A	N/A	N/A
Apr-06	0	N/A	0	0	N/A	N/A	N/A
May-06	0	N/A	0	0	N/A	N/A	N/A
Jun-06	0	N/A	0	0	N/A	N/A	N/A
Jul-06	0	N/A	0	0	N/A	N/A	N/A
Aug-06	0	N/A	0	0	N/A	N/A	N/A
Sep-06	30	9.46	31,029	34,193	-10.19%	19%	21%
Oct-06	31	10.68	47,426	48,998	-3.31%	28%	29%
Nov-06	29	10.95	52,037	47,229	9.24%	33%	30%
Dec-06	31	10.81	49,476	49,711	-0.47%	30%	30%
Total	121		179,969	180,130	-0.09%	28%	28%
Total in OSP (07/15-09/15)	15	7.90	9,384	9,544	-1.71%	12%	12%

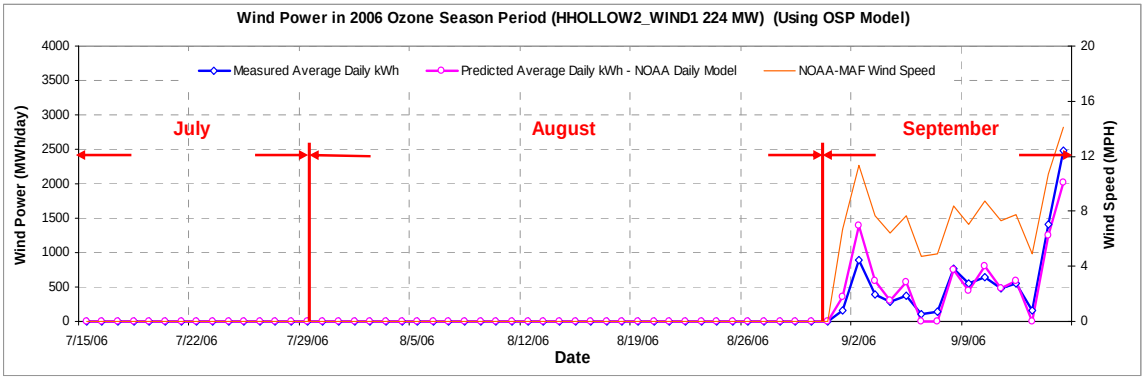


Figure 12-23: H_HOLLOW_WND2 – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

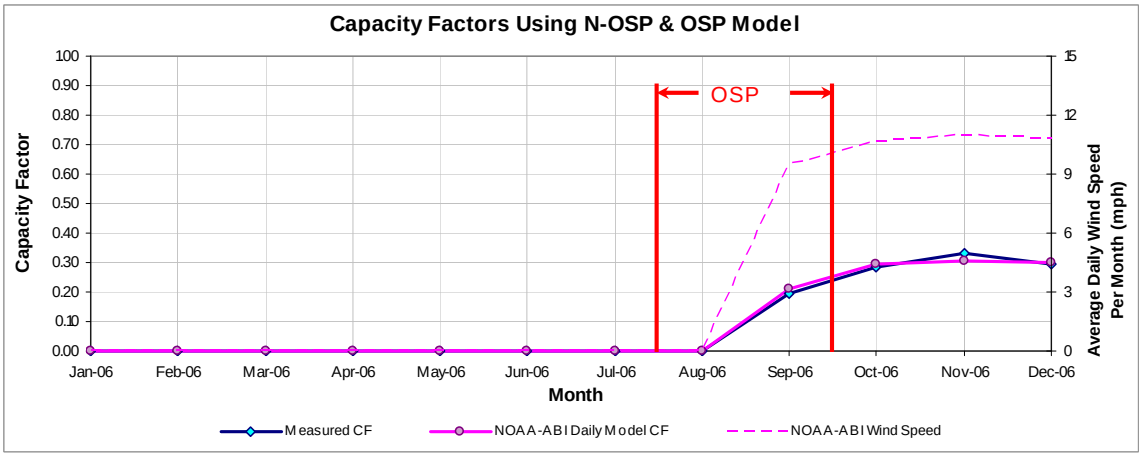


Figure 12-24: H_HOLLOW_WND2 – Predicted Capacity Factors Using Daily Models (2006).

Table 12-24: H_HOLLOW_WND2 – Predicted Power Production in 1999

Annual

1999 Estimated MWh/yr (2006 Daily Model)	2006 Measured MWh/yr for Modeling
594,059	542,882

OSD

1999 OSD Estimated MWh/day (2006 Daily Model)	2006 OSD Measured MWh/day for Modeling
1,029	626

1999 (Aug-Dec) Estimated MWh/yr (2006 Daily Model)	2006 (Aug-Dec) Measured MWh/yr
198,696	227,564

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.6 Horse Hollow 3

Table 12-25: Site Information for Horse Hollow 3.

GENSITECODE_ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Interconnection	Weather Station
HHOLLOW3_WND_1	WIND	Abilene	Taylor	May-06	160	FPL Energy	Horse Hollow Phase 4	Mitsubishi 1000 (160)	ERCOT	AEP-West	AEP/ TNC	MAF

SUBGENCODE_ERCOT	GENSITECODE_ERCOT	Capacity (MW)
HHOLLOW3_WND_1	HHOLLOW3_WND_1	299

12.6.1 Horse Hollow 3 – H_HOLLOW_WND3

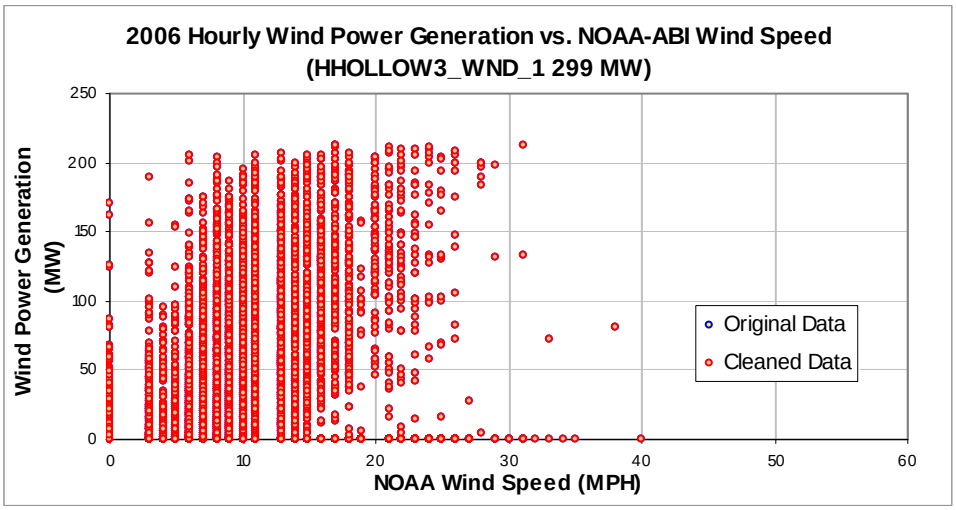


Figure 12-25: H_HOLLOW_WND3 – Hourly Wind Power vs. NOAA Wind Speed (2006).

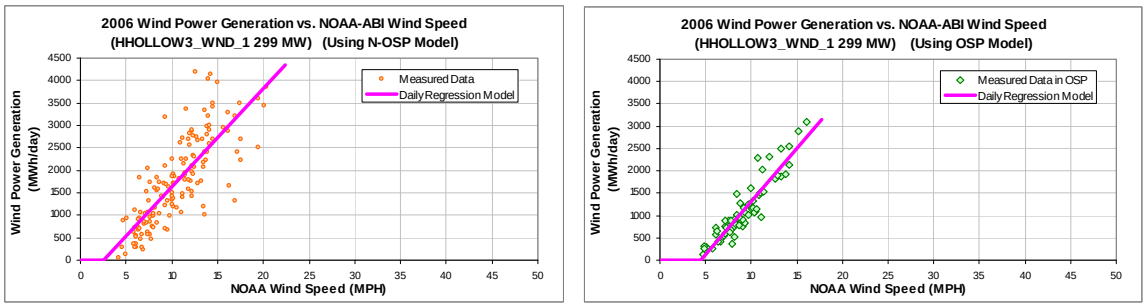


Figure 12-26: H_HOLLOW_WND3 – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-26: H_HOLLOW_WND3 – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-572.24
Left Slope (MWh/mph-day)	219.73
RMSE (MWh/day)	590.85
R2	0.63
CV-RMSE	33.80%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-1049.85
Left Slope (MWh/mph-day)	236.48
RMSE (MWh/day)	265.7341
R2	0.8501
CV-RMSE	23.8%

Table 12-27: H_HOLLOW_WND3 – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	0	N/A	0	0	N/A	N/A	N/A
Feb-06	0	N/A	0	0	N/A	N/A	N/A
Mar-06	0	N/A	0	0	N/A	N/A	N/A
Apr-06	0	N/A	0	0	N/A	N/A	N/A
May-06	0	N/A	0	0	N/A	N/A	N/A
Jun-06	30	9.83	33,160	47,604	-43.56%	15%	22%
Jul-06	31	10.15	43,635	46,186	-5.85%	20%	21%
Aug-06	31	9.16	31,870	34,570	-8.47%	14%	16%
Sep-06	30	9.46	39,503	40,037	-1.35%	18%	19%
Oct-06	31	10.68	57,670	55,043	4.55%	26%	25%
Nov-06	29	10.95	65,387	53,160	18.70%	31%	26%
Dec-06	31	10.81	61,274	55,898	8.77%	28%	25%
Total	213		332,498	332,498	0.00%	22%	22%
Total in OSP (07/15-09/15)	63	9.16	70,305	70,305	0.00%	16%	16%

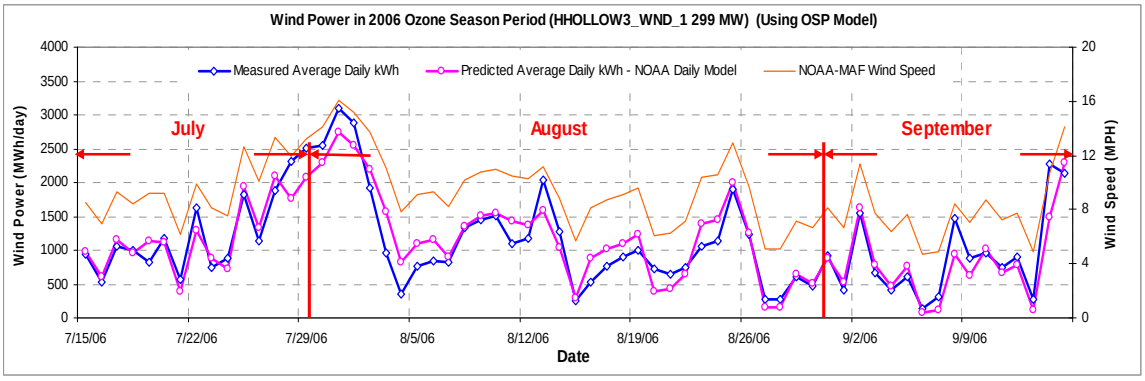


Figure 12-27: H_HOLLOW_WND3 – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

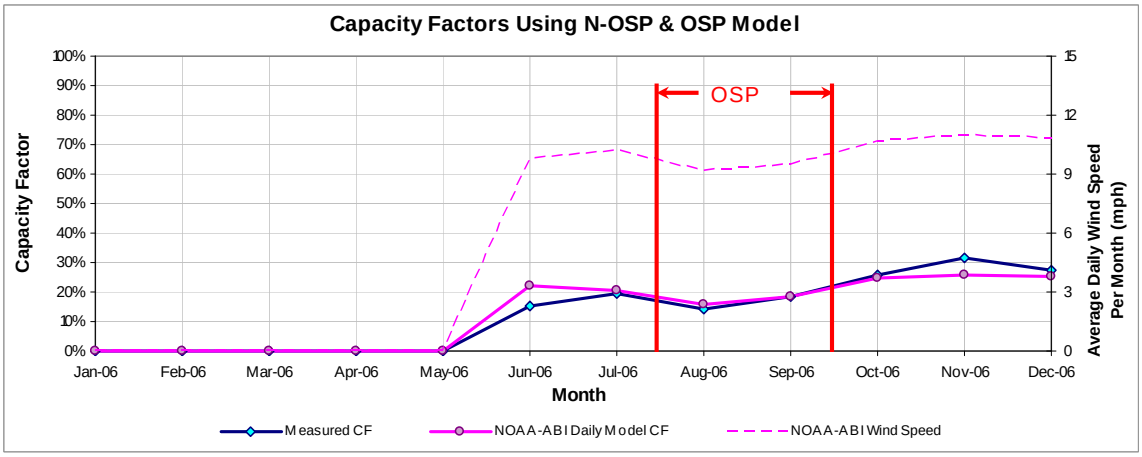


Figure 12-28: H_HOLLOW_WND3 – Predicted Capacity Factors Using Daily Models (2006).

Table 12-28: H_HOLLOW_WND3 – Predicted Power Production in 1999.

Annual

1999 Estimated MWh/yr (2006 Daily Model)	2006 Measured MWh/yr for Modeling
676,954	569,774

OSD

1999 OSD Estimated MWh/day (2006 Daily Model)	2006 OSD Measured MWh/day for Modeling
1,246	1,116

1999 (June-Dec) Estimated MWh/yr (2006 Daily Model)	2006 (June-Dec) Measured MWh/yr
351,472	334,059

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.7 Horse Hollow 4

Table 12-29: Site Information for Horse Hollow 4.

GENSITECODE_ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Interconnection	Weather Station
HOLLOW4_WND	WIND	Abilene	Taylor	May-06	115	FPL Energy	Horse Hollow Phase 4	Mitsubishi 1000 (160)	ERCOT	AEP-West	AEP/ TNC	ABI

SUBGENCODE_ERCOT	GENSITECODE_ERCOT	Capacity (MW)
HOLLOW4_WND	HOLLOW4_WND	112

12.7.1 Horse Hollow 4 – H_HOLLOW_WND4

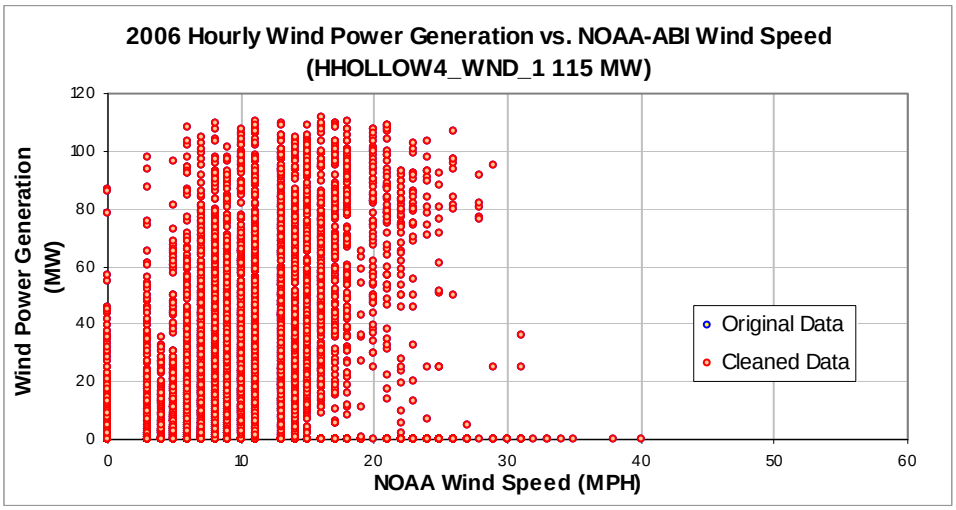


Figure 12-29: H_HOLLOW_WND4 – Hourly Wind Power vs. NOAA Wind Speed (2006).

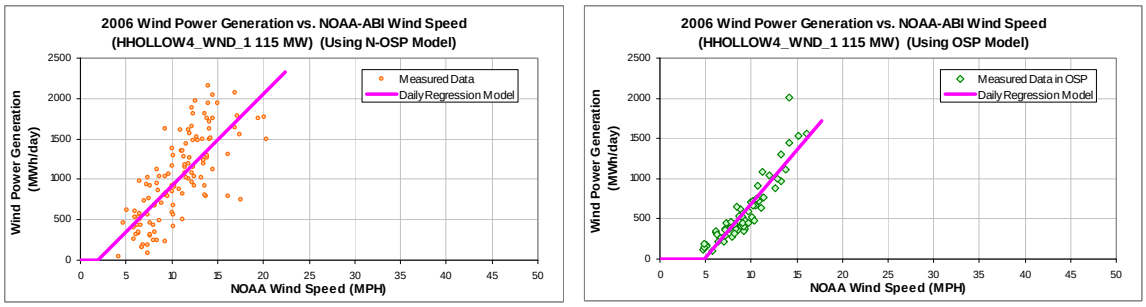


Figure 12-30: H_HOLLOW_WND 4 – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-30: H_HOLLOW_WND 4 – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-213.14
Left Slope (MWh/mph-day)	113.65
RMSE (MWh/day)	350.86
R2	0.56
CV-RMSE	34.82%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-640.1283
Left Slope (MWh/mph-day)	133.598
RMSE (MWh/day)	157.54
R2	0.8374
CV-RMSE	27.0%

Table 12-31: H_HOLLOW_WND 4 – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	0	N/A	0	0	N/A	N/A	N/A
Feb-06	0	N/A	0	0	N/A	N/A	N/A
Mar-06	0	N/A	0	0	N/A	N/A	N/A
Apr-06	0	N/A	0	0	N/A	N/A	N/A
May-06	0	N/A	0	0	N/A	N/A	N/A
Jun-06	0	N/A	0	0	N/A	N/A	N/A
Jul-06	31	10.15	18,873	25,368	-34.42%	22%	30%
Aug-06	31	9.16	17,141	18,073	-5.44%	20%	21%
Sep-06	30	9.46	24,255	21,837	9.97%	29%	26%
Oct-06	31	10.68	30,576	31,037	-1.51%	36%	36%
Nov-06	29	10.95	35,201	29,897	15.07%	44%	37%
Dec-06	31	10.81	31,639	31,479	0.51%	37%	37%
Total	183		157,684	157,691	0.00%	31%	31%
Total in OSP (07/15-09/15)	63	9.16	36,757	36,764	-0.02%	21%	21%

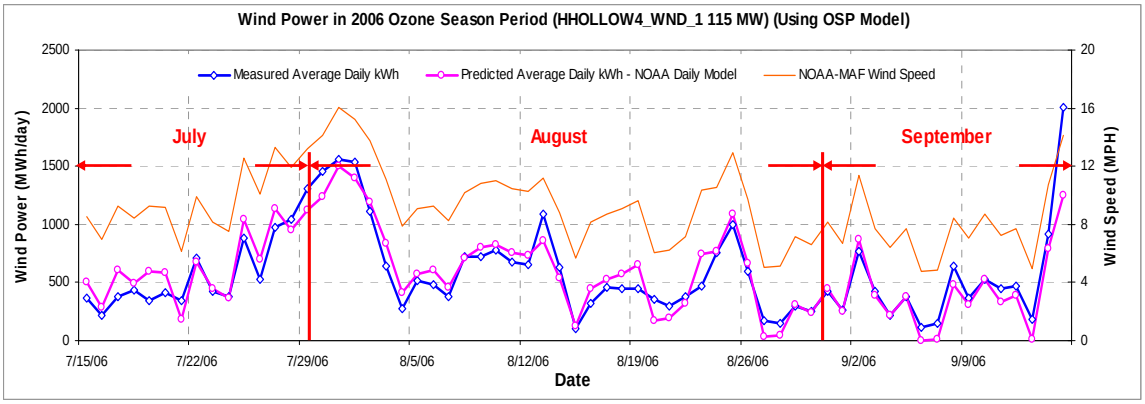


Figure 12-31: H_HOLLOW_WND 4 – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

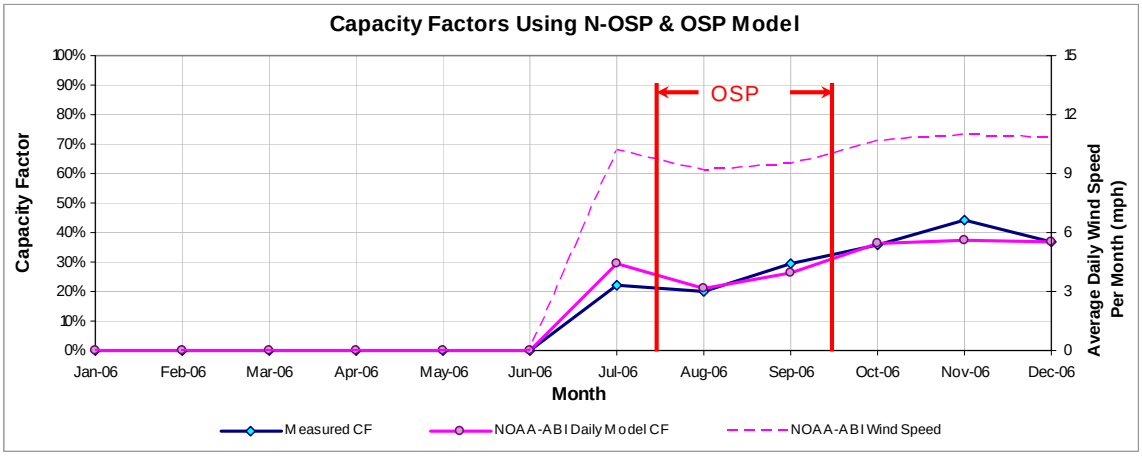


Figure 12-32: H_HOLLOW_WND 4 – Predicted Capacity Factors Using Daily Models (2006).

Table 12-32: H_HOLLOW_WND 4 – Predicted Power Production in 1999.

Annual

1999 Estimated MWh/yr (2006 Daily Model)	2006 Measured MWh/yr for Modeling
375,919	314,507

OSD

1999 OSD Estimated MWh/day (2006 Daily Model)	2006 OSD Measured MWh/day for Modeling
657	583

1999 (June-Dec) Estimated MWh/yr (2006 Daily Model)	2006 (June-Dec) Measured MWh/yr
195,070	184,396

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.8 _Desert Sky

Table 12-33: Site Information for Desert Sky.

GENSITECODE_ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Intercon-nection	Weather Station
INDNENR	WIND	Iraan	PECOS	Dec-01	160.5	AEP	Desert Sky (Indian Mesa II)	Enron 1500 (107)	ERCOT	TXU	WTU	FST

SUBGENCODE_ERCOT	GENSITECODE_ERCOT	Capacity (MW)
INDNENR_INDNENR	INDNENR	
INDNENR_INDNENR_2	INDNENR	

12.8.1 Desert Sky – INDNENR_INDNENR

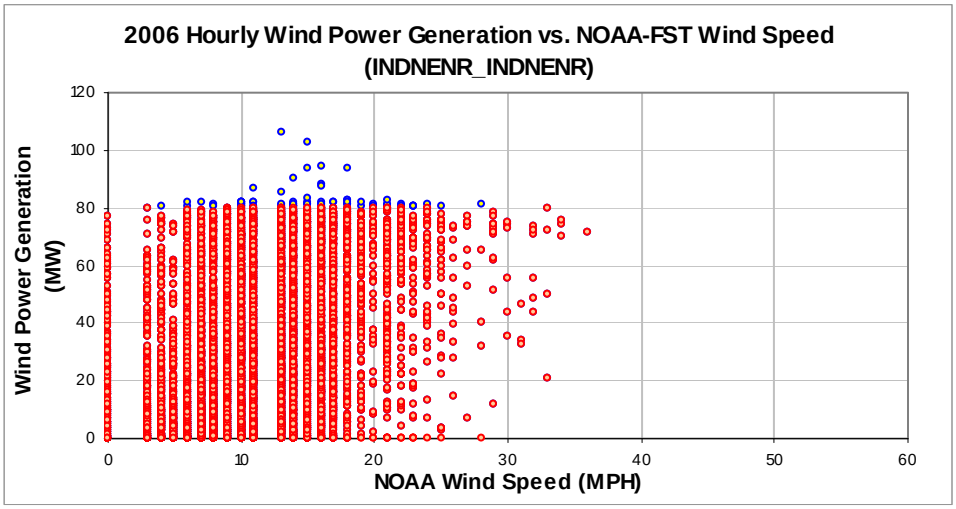


Figure 12-33: INDNENR_INDNENR – Hourly Wind Power vs. NOAA Wind Speed (2006).

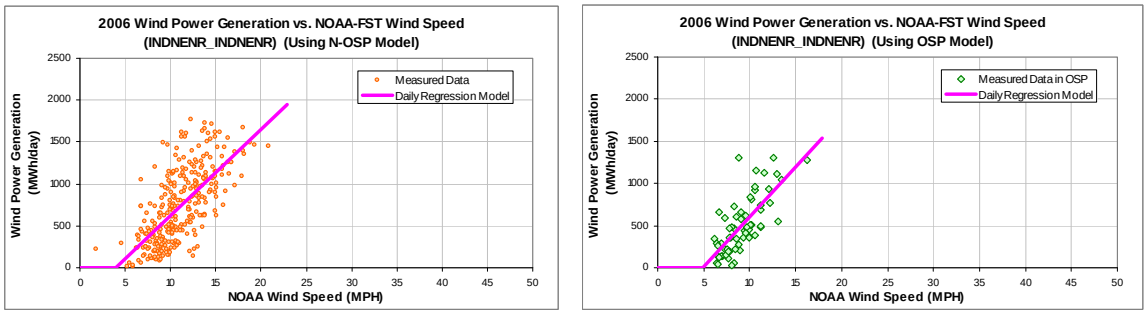


Figure 12-34: INDNENR_INDNENR – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-34: INDNENR_INDNENR – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-400.67
Left Slope (MWh/mph-day)	102.57
RMSE (MWh/day)	320.7
R2	0.47
CV-RMSE	43.41%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-579.80
Left Slope (MWh/mph-day)	117.98
RMSE (MWh/day)	229.95
R2	0.5385
CV-RMSE	45.5%

Table 12-35: INDNENR_INDNENR – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	29	11.08	22,103	21,561	2.45%	40%	39%
Feb-06	27	10.24	17,408	17,534	-0.72%	34%	34%
Mar-06	31	11.75	24,739	24,940	-0.81%	42%	42%
Apr-06	30	12.12	24,515	25,288	-3.15%	43%	44%
May-06	31	12.32	29,442	26,761	9.10%	49%	45%
Jun-06	29	10.93	18,192	20,883	-14.79%	33%	38%
Jul-06	31	10.57	19,884	20,839	-4.80%	33%	35%
Aug-06	31	8.91	14,330	14,626	-2.06%	24%	25%
Sep-06	30	9.48	15,936	16,454	-3.25%	28%	29%
Oct-06	31	10.49	22,157	20,945	5.47%	37%	35%
Nov-06	30	10.99	24,608	21,803	11.40%	43%	38%
Dec-06	31	10.38	18,695	20,590	-10.14%	31%	35%
Total	361		252,010	252,223	-0.08%	36%	36%
Total in OSP (07/15-09/15)	63	9.20	31,864	31,864	0.00%	26%	26%

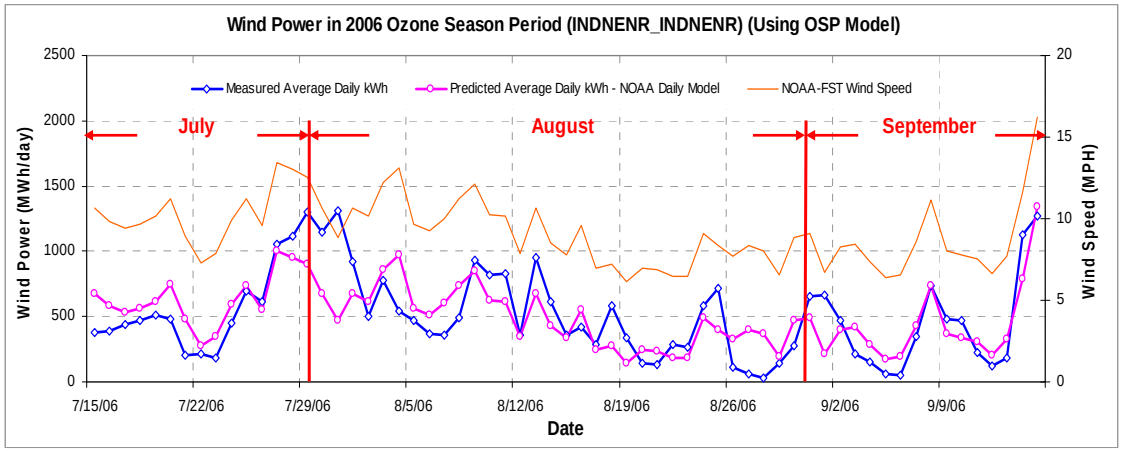


Figure 12-35: INDNENR_INDNENR – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

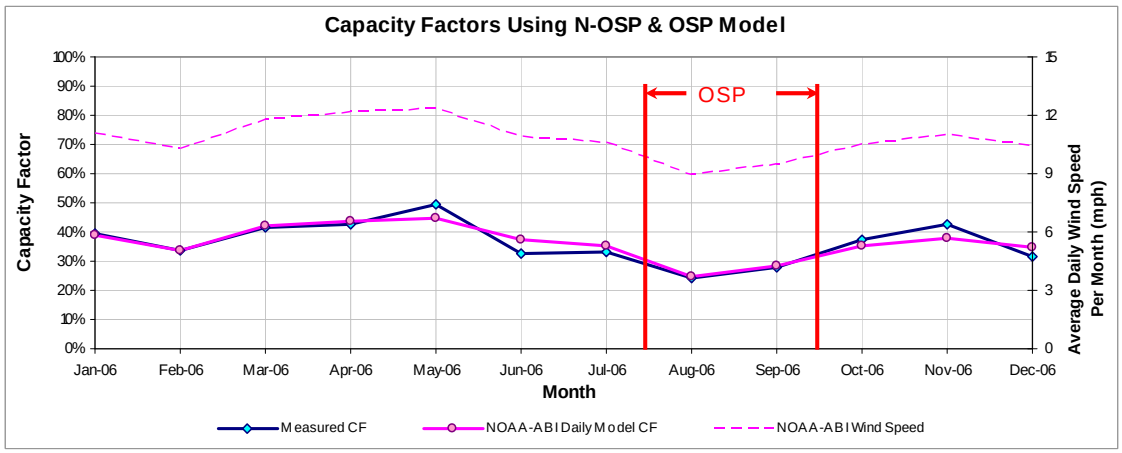


Figure 12-36: INDNENR_INDNENR – Predicted Capacity Factors Using Daily Models (2006).

Table 12-36: INDNENR_INDNENR – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	**2006 Measured MWh/yr for Modeling**	**1999 OSD Estimated MWh/day (2006 Daily Model)**	**2006 OSD Measured MWh/day for Modeling**
270,994	**254,802**	**595**	**506**

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.8.2 Desert Sky – INDNENR_INDNENR_2

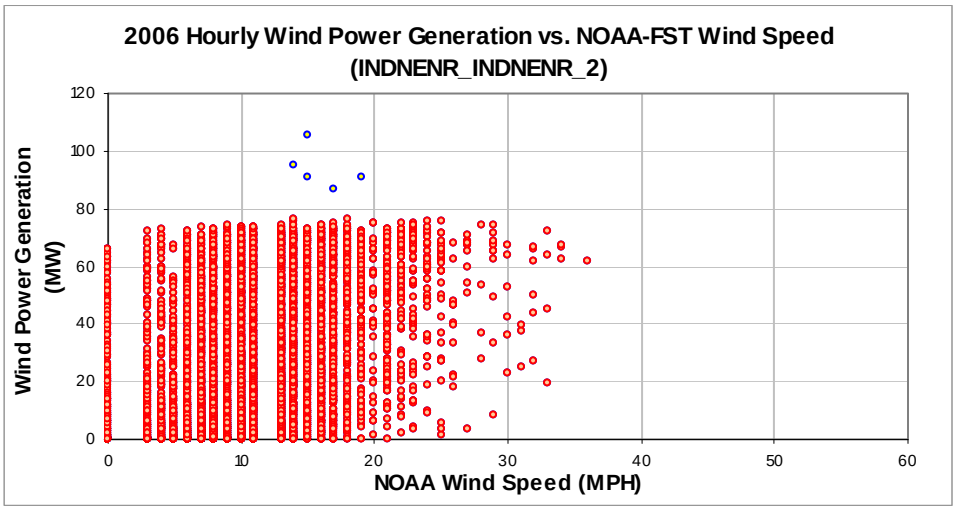


Figure 12-37: INDNENR_INDNENR_2 – Hourly Wind Power vs. NOAA Wind Speed (2006).

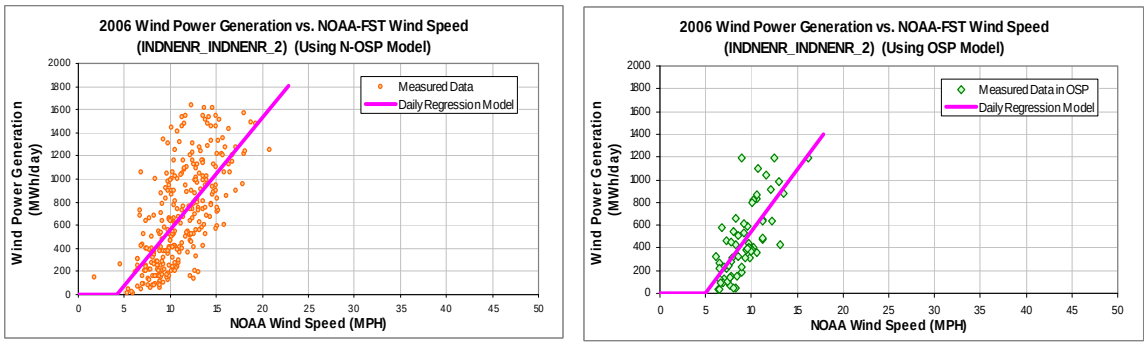


Figure 12-38: INDNENR_INDNENR_2 – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-37: INDNENR_INDNENR_2 – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-396.37
Left Slope (MWh/mph-day)	96.11
RMSE (MWh/day)	314.81
R2	0.44
CV-RMSE	46.89%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-544.64
Left Slope (MWh/mph-day)	108.6434
RMSE (MWh/day)	218.40
R2	0.5231
CV-RMSE	48.0%

Table 12-38: INDNENR_INDNENR_2 – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	29	11.08	19,744	19,589	0.79%	35%	35%
Feb-06	28	10.24	16,442	16,417	0.15%	31%	31%
Mar-06	31	11.75	21,953	22,690	-3.35%	37%	38%
Apr-06	30	12.12	22,615	23,038	-1.87%	39%	40%
May-06	31	12.32	26,659	24,396	8.49%	45%	41%
Jun-06	30	11.07	17,257	20,004	-15.92%	30%	35%
Jul-06	31	10.57	18,303	18,864	-3.06%	31%	32%
Aug-06	31	8.91	12,772	13,136	-2.85%	21%	22%
Sep-06	30	9.48	14,280	14,822	-3.80%	25%	26%
Oct-06	31	10.49	20,360	18,946	6.95%	34%	32%
Nov-06	30	10.99	22,052	19,771	10.34%	38%	34%
Dec-06	31	10.38	17,625	18,613	-5.60%	30%	31%
Total	363		230,063	230,284	-0.10%	33%	33%
Total in OSP (07/15-09/15)	63	9.20	28,667	28,667	0.00%	24%	24%

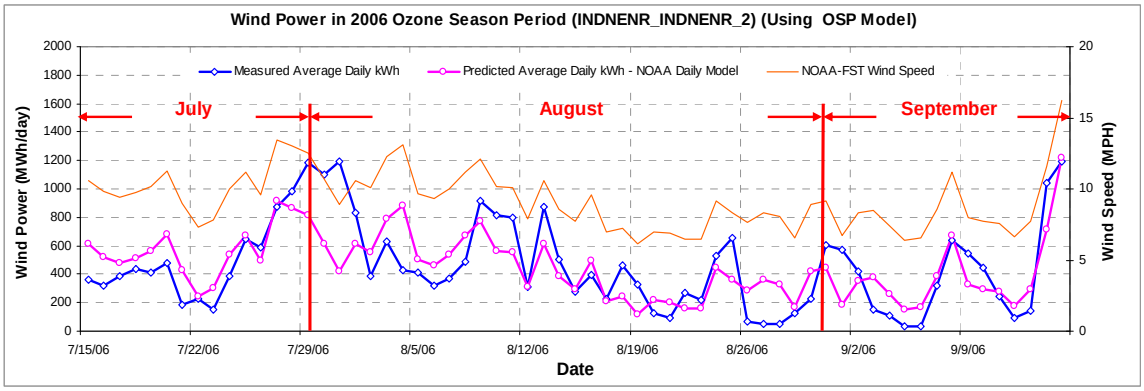


Figure 12-39: INDNENR_INDNENR_2 – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

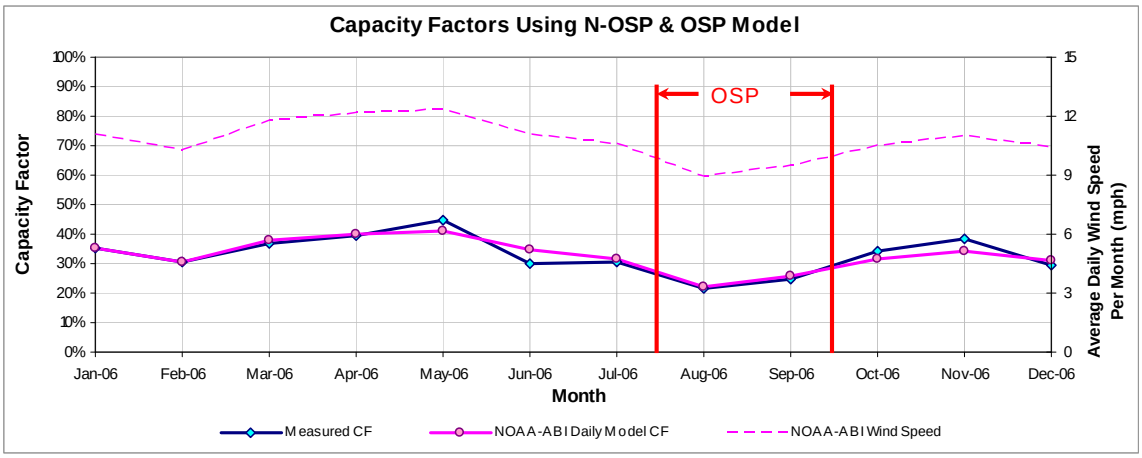


Figure 12-40: INDNENR_INDNENR_2 – Predicted Capacity Factors Using Daily Models (2005).

Table 12-39: INDNENR_INDNENR_2 – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	**2006 Measured MWh/yr for Modeling**	**1999 OSD Estimated MWh/day (2006 Daily Model)**	**2006 OSD Measured MWh/day for Modeling**
246,042	**231,330**	**537**	**455**

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.9 King Mountain Wind Ranch (KING_NE)

Table 12-40: Site Information for King Mountain Wind Ranch (KING_NE).

GENSITECODE_ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Interconnection	Weather Station
KING_NE	WIND	McCamey	UPTON	Dec-01	79.3	FPL/Cielo	King Mountain Wind Ranch	Bonus 1300 (61)	ERCOT	AEP-West	WTU	MAF

SUBGENCODE_ERCOT	GENSITECODE_ERCOT	Capacity (MW)
KING_NE_KINGNE	KING_NE	79.3

12.9.1 King Mountain – KING_NE_KINGNE

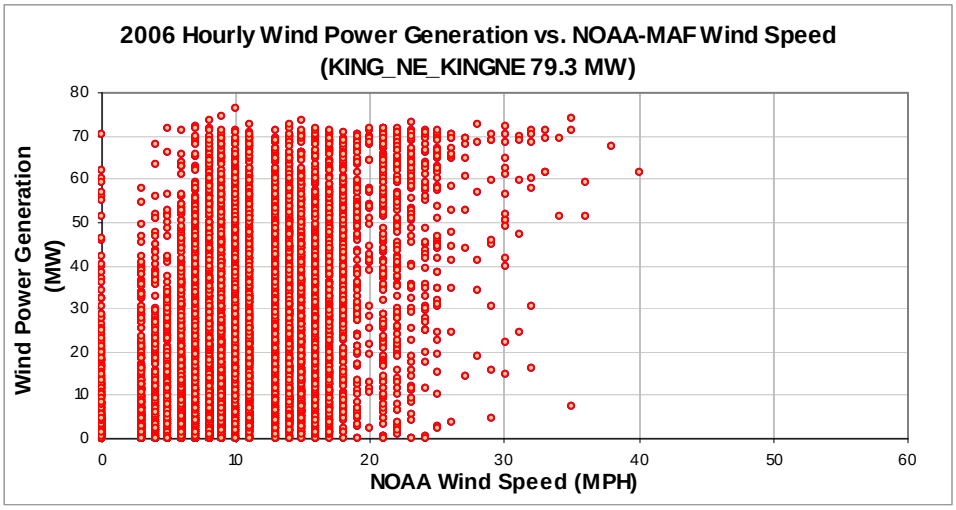


Figure 12-41: KING_NE_KINGNE – Hourly Wind Power vs. NOAA Wind Speed (2006).

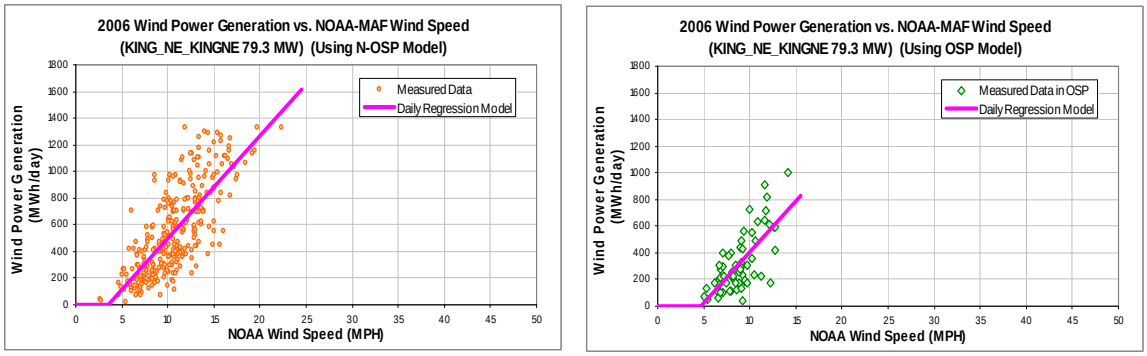


Figure 12-42: KING_NE_KINGNE – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-41: KING_NE_KINGNE – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-278.17
Left Slope (MWh/mph-day)	77.47
RMSE (MWh/day)	212.00
R2	0.58
CV-RMSE	38.41%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-356.88
Left Slope (MWh/mph-day)	76.23
RMSE (MWh/day)	154.77
R2	0.51
CV-RMSE	48.1%

Table 12-42: KING_NE_KINGNE – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	31	10.59	18,241	16,953	7.06%	31%	29%
Feb-06	28	9.89	12,728	13,662	-7.34%	24%	26%
Mar-06	31	11.92	19,767	20,016	-1.26%	34%	34%
Apr-06	30	12.20	20,862	20,019	4.04%	37%	35%
May-06	31	12.00	21,837	20,196	7.51%	37%	34%
Jun-06	30	10.70	13,534	16,527	-22.11%	24%	29%
Jul-06	31	10.30	12,780	14,563	-13.95%	22%	25%
Aug-06	31	8.39	8,785	8,765	0.22%	15%	15%
Sep-06	30	9.58	11,886	12,579	-5.83%	21%	22%
Oct-06	31	9.95	15,297	15,281	0.10%	26%	26%
Nov-06	30	9.78	17,849	14,397	19.34%	31%	25%
Dec-06	31	9.47	13,371	14,116	-5.57%	23%	24%
Total	365		186,937	187,073	-0.07%	27%	27%
Total in OSP (07/15-09/15)	63	8.90	20,255	20,255	0.00%	17%	17%

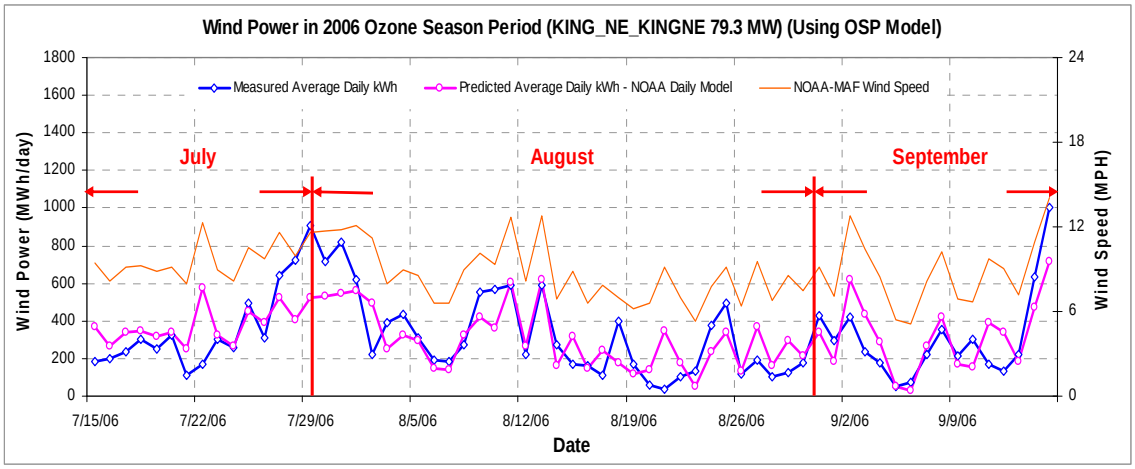


Figure 12-43: KING_NE_KINGNE – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

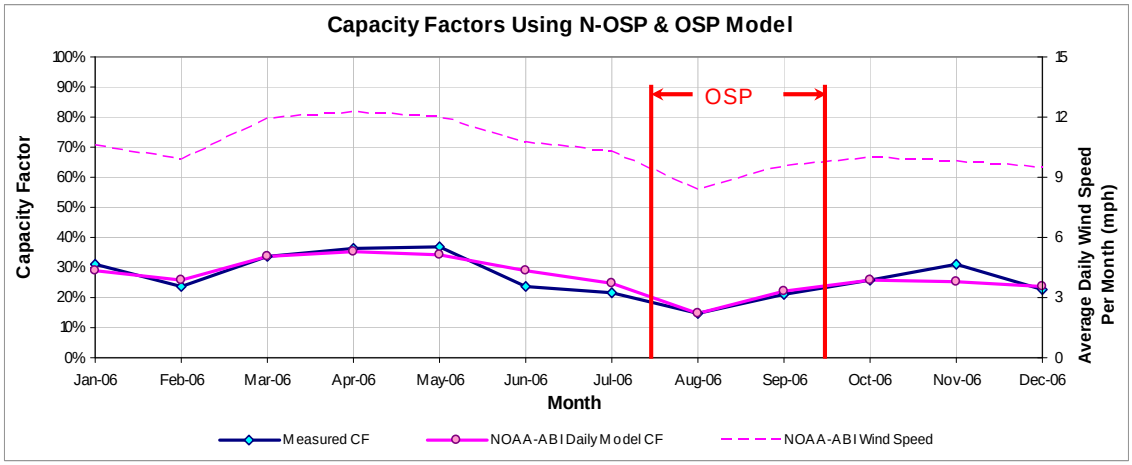


Figure 12-44: KING_NE_KINGNE – Predicted Capacity Factors Using Daily Models (2006).

Table 12-43: KING_NE_KINGNE – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	2006 Measured MWh/yr for Modeling	1999 OSD Estimated MWh/day (2006 Daily Model)	2006 OSD Measured MWh/day for Modeling
201,259	186,937	365	322

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.10 King Mountain Wind Ranch (KING_NW)

Table 12-44: Site Information for King Mountain Wind Ranch (KING_NW).

GENSITECODE_ ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Interconne-ction	Weather Station
KING_NW	WIND	McCamey	UPTON	Dec-01	79.3	FPL/Cielo	King Mountain Wind Ranch	Bonus 1300 (61)	ERCOT	AEP-West	WTU	MAF

SUBGENCODE_ ERCOT	GENSITECODE _ERCOT	Capacity (MW)
KING_NW_KING NW	KING_NW	79.3

12.10.1 King Mountain – KING_NW_KINGNW

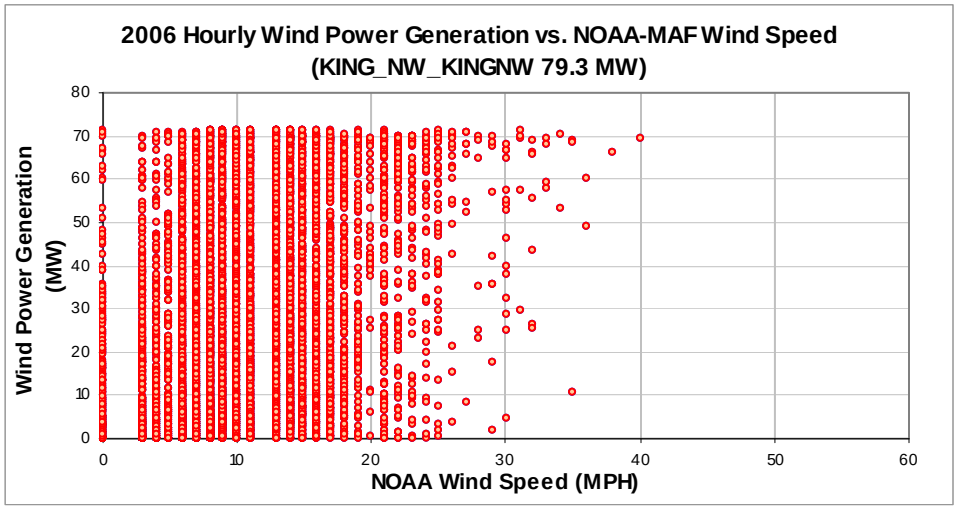


Figure 12-45: KING_NW_KINGNW – Hourly Wind Power vs. NOAA Wind Speed (2006).

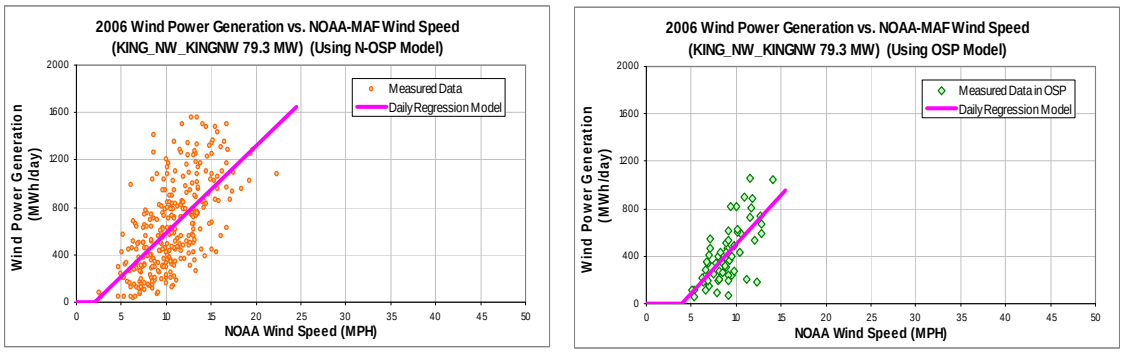


Figure 12-46: KING_NW_KINGNW – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-45: KING_NW_KINGNW – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-151.36
Left Slope (MWh/mph-day)	73.45
RMSE (MWh/day)	284.50
R2	0.40
CV-RMSE	45.23%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-329.154
Left Slope (MWh/mph-day)	82.83
RMSE (MWh/day)	176.80
R2	0.4832
CV-RMSE	43.3%

Table 12-46: KING_NW_KINGNW – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	31	10.59	17,816	19,426	-9.04%	30%	33%
Feb-06	28	9.89	14,081	16,098	-14.32%	26%	30%
Mar-06	31	11.92	23,859	22,459	5.87%	40%	38%
Apr-06	30	12.20	23,447	22,349	4.68%	41%	39%
May-06	31	12.00	25,134	22,630	9.96%	43%	38%
Jun-06	30	10.70	16,734	19,039	-13.77%	29%	33%
Jul-06	31	10.30	16,132	17,313	-7.32%	27%	29%
Aug-06	31	8.39	10,747	11,341	-5.52%	18%	19%
Sep-06	30	9.58	16,285	15,144	7.00%	29%	27%
Oct-06	31	9.95	18,622	17,970	3.50%	32%	30%
Nov-06	30	9.78	20,605	17,019	17.40%	36%	30%
Dec-06	31	9.47	14,190	16,865	-18.85%	24%	29%
Total	365		217,652	217,652	0.00%	31%	31%
Total in OSP (07/15-09/15)	63	8.90	25,701	25,701	0.00%	21%	21%

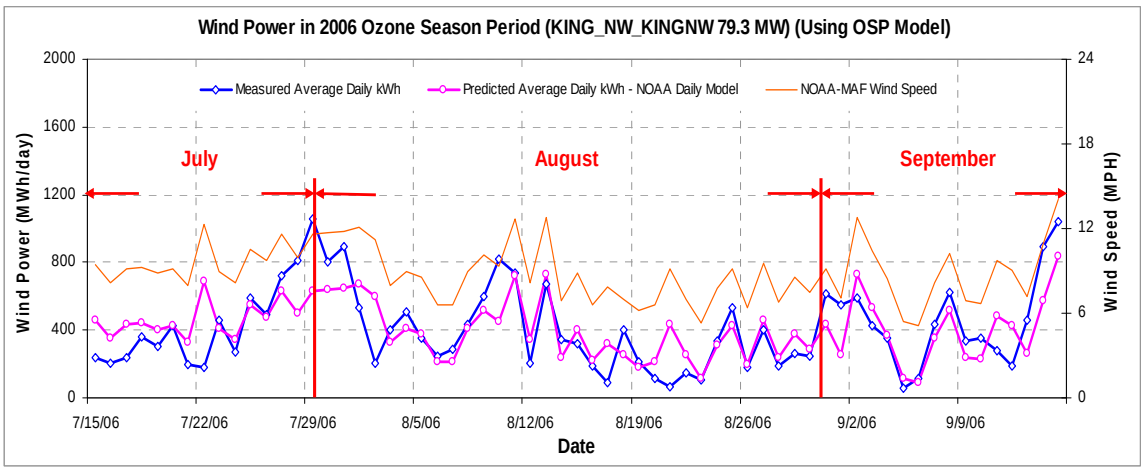


Figure 12-47: KING_NW_KINGNW – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

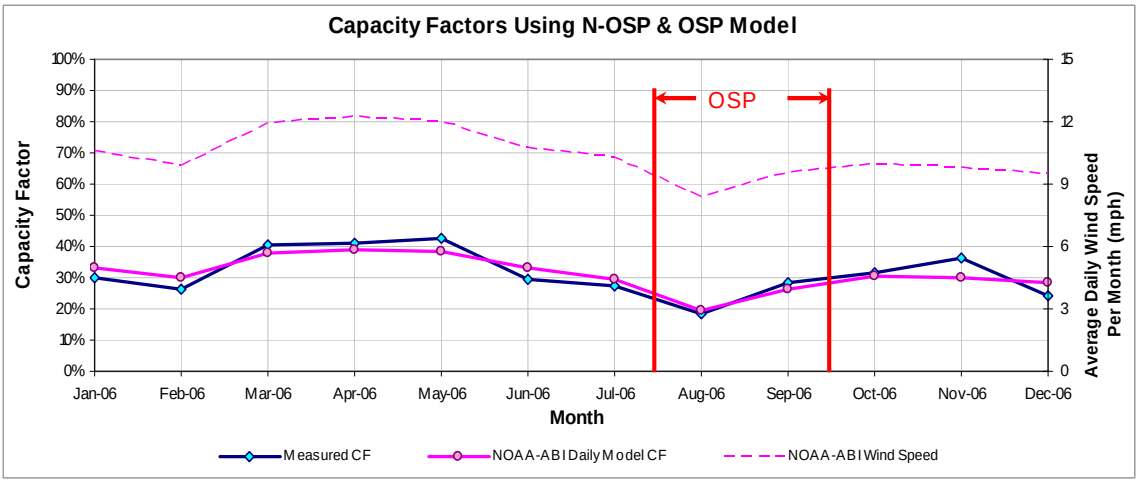


Figure 12-48: KING_NW_KINGNW – Predicted Capacity Factors Using Daily Models (2006).

Table 12-47: KING_NW_KINGNW – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	2006 Measured MWh/yr for Modeling	1999 OSD Estimated MWh/day (2006 Daily Model)	2006 OSD Measured MWh/day for Modeling
231,449	217,652	455	408

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.11 King Mountain Wind Ranch (KING_SE)

Table 12-48: Site Information for King Mountain Wind Ranch (KING_SE).

GENSITECODE_ ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Intercon-nection	Weather Station
KING_SE	WIND	McCamey	UPTON	Dec-01	40.3	FPL/Cielo	King Mountain Wind Ranch	Bonus 1300 (61)	ERCOT	AEP-West	WTU	MAF

SUBGENCODE_ ERCOT	GENSITECO DE_ERCOT	Capacity (MW)
KING_SE_KINGS E	KING_SE	40.3

12.11.1 King Mountain – KING_SE_KINGSE

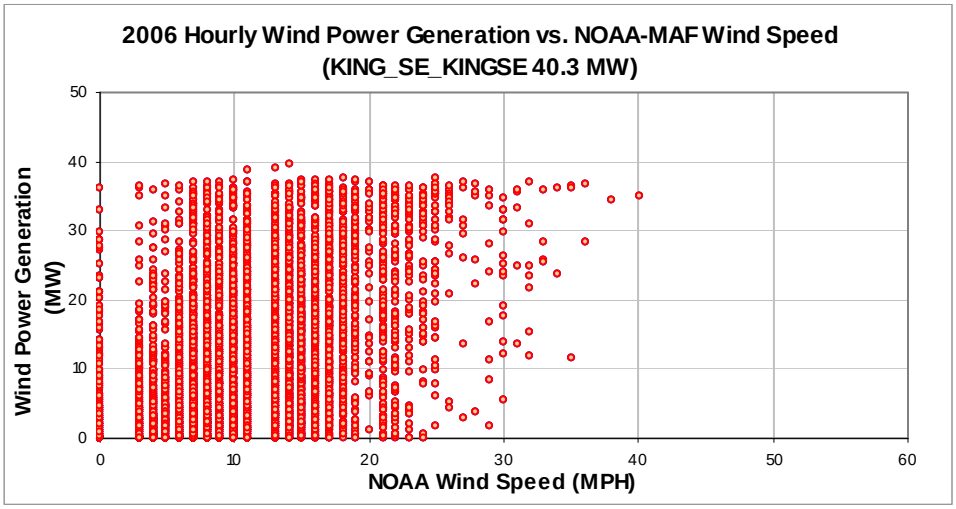


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Figure 12-49: KING_SE_KINGSE – Hourly Wind Power vs. NOAA Wind Speed (2006).

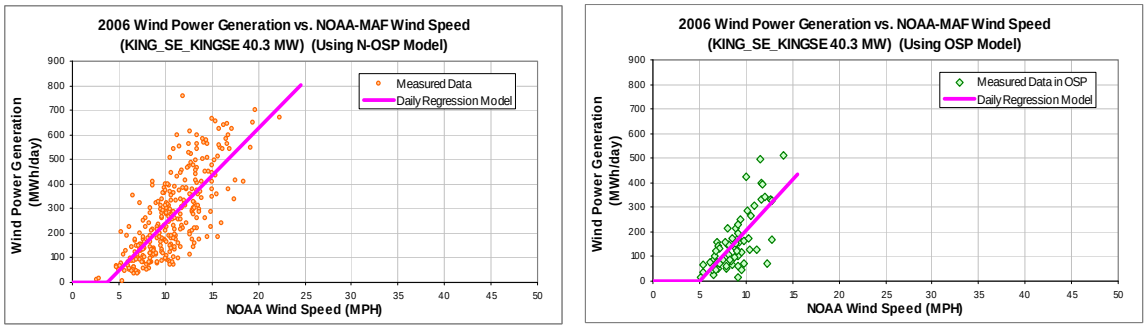

Figure 12-50: KING_SE_KINGSE – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-49: KING_SE_KINGSE – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-146.33
Left Slope (MWh/mph-day)	38.70
RMSE (MWh/day)	109.84
R2	0.56
CV-RMSE	40.93%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-209.597
Left Slope (MWh/mph-day)	41.6
RMSE (MWh/day)	83.33
R2	0.515
CV-RMSE	51.9%

Table 12-50: King Mountain – KING_ SE – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	31	10.59	9,632	8,254	14.30%	32%	28%
Feb-06	28	9.89	6,675	6,618	0.85%	25%	24%
Mar-06	31	11.92	9,389	9,770	-4.06%	31%	33%
Apr-06	30	12.20	9,973	9,778	1.95%	34%	34%
May-06	31	12.00	9,916	9,860	0.57%	33%	33%
Jun-06	30	10.70	6,612	8,034	-21.50%	23%	28%
Jul-06	31	10.30	6,546	7,232	-10.47%	22%	24%
Aug-06	31	8.39	4,412	4,323	2.01%	15%	14%
Sep-06	30	9.58	5,216	6,168	-18.25%	18%	21%
Oct-06	31	9.95	7,454	7,405	0.66%	25%	25%
Nov-06	30	9.78	8,207	6,970	15.07%	28%	24%
Dec-06	31	9.47	7,119	6,822	4.17%	24%	23%
Total	365		91,151	91,234	-0.09%	26%	26%
Total in OSP (07/15-09/15)	63	8.90	10,119	10,119	0.00%	17%	17%

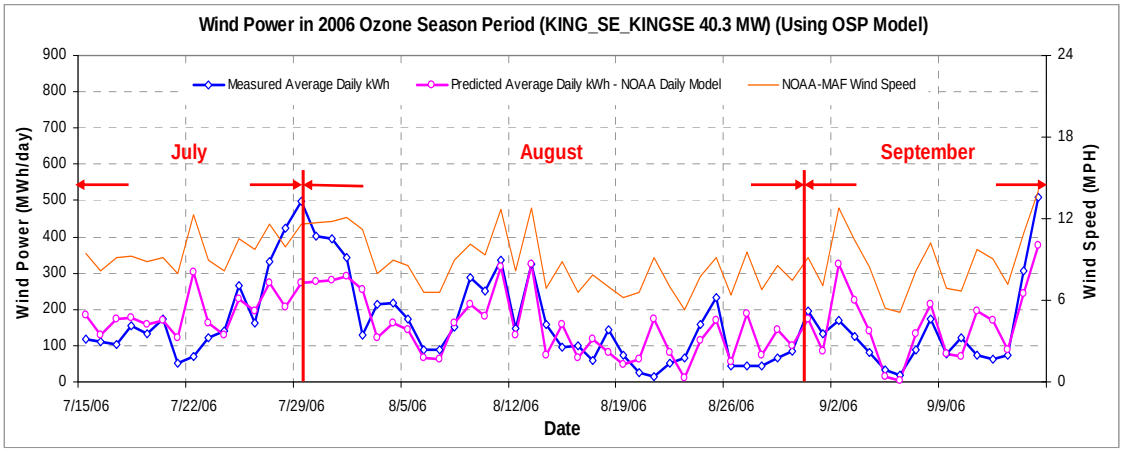

Figure 12-51: KING_SE_KINGSE – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

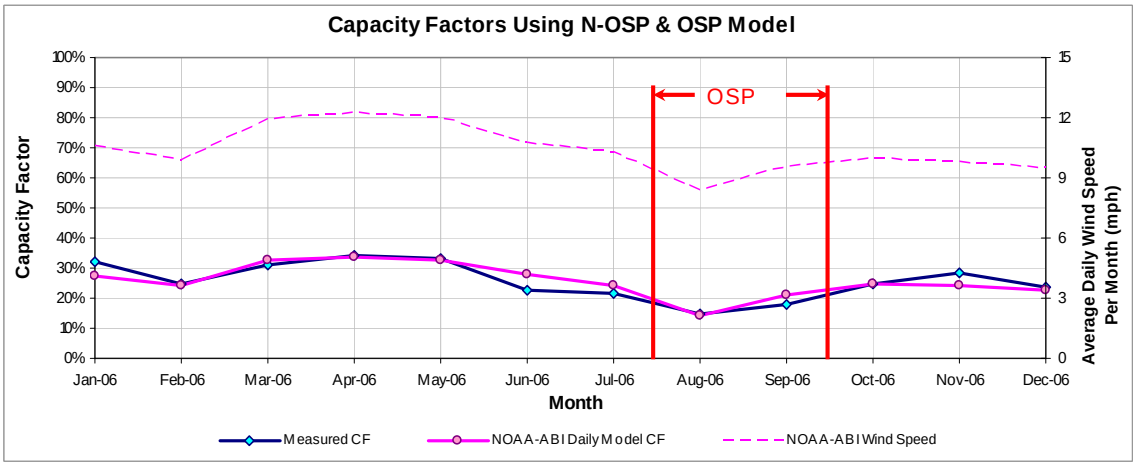

Figure 12-52: KING_SE_KINGSE – Predicted Capacity Factors Using Daily Models (2006).

Table 12-51: KING_SE_KINGSE - Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	2006 Measured MWh/yr for Modeling	1999 OSD Estimated MWh/day (2006 Daily Model)	2006 OSD Measured MWh/day for Modeling
98,462	91,151	185	161

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.12 King Mountain Wind Ranch (KING_SW)

Table 12-52: Site Information for King Mountain Wind Ranch (KING_SW).

GENSITECODE_ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Interconnection	Weather Station
KING_SW	WIND	McCamey	UPTON	Dec-01	79.3	FPL/Cielo	King Mountain Wind Ranch	Bonus 1300 (61)	ERCOT	AEP-West	WTU	MAF

SUBGENCODE_ERCOT	GENSITECODE_ERCOT	Capacity (MW)
KING_SW_KINGSW	KING_SW	79.3

12.12.1 King Mountain – KING_SW_KINGSW

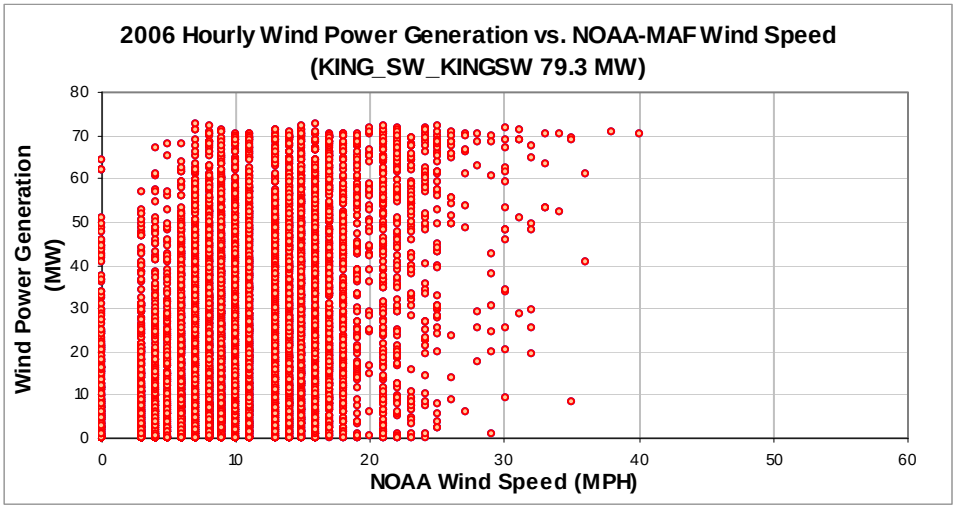

Figure 12-53: KING_SW_KINGSW – Hourly Wind Power vs. NOAA Wind Speed (2006).

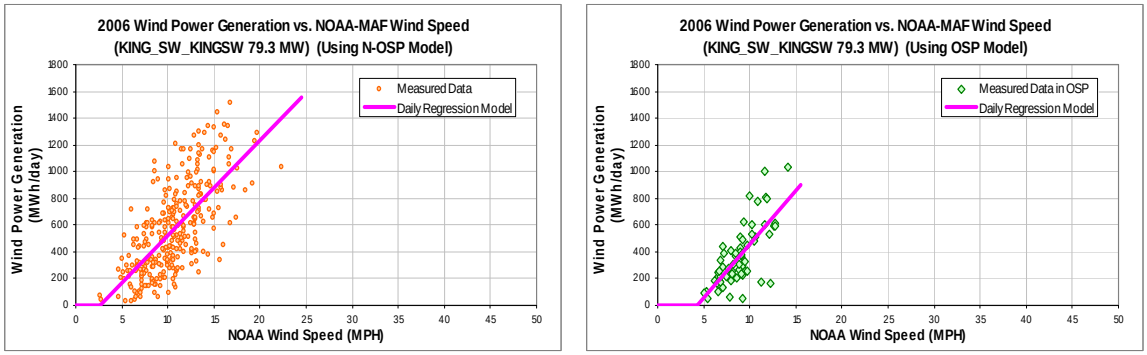

Figure 12-54: KING_SW_KINGSW – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-53: KING_SW_KINGSW – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-188.12
Left Slope (MWh/mph-day)	71.18
RMSE (MWh/day)	240.61
R2	0.47
CV-RMSE	41.88%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-348.37
Left Slope (MWh/mph-day)	80.58
RMSE (MWh/day)	156.37
R2	0.531
CV-RMSE	42.4%

Table 12-54: KING_SW_KINGSW – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	31	10.59	16,432	17,545	-6.77%	28%	30%
Feb-06	28	9.89	12,971	14,440	-11.32%	24%	27%
Mar-06	31	11.92	22,145	20,480	7.52%	38%	35%
Apr-06	30	12.20	21,555	20,415	5.29%	38%	36%
May-06	31	12.00	21,545	20,645	4.17%	37%	35%
Jun-06	30	10.70	15,086	17,207	-14.06%	26%	30%
Jul-06	31	10.30	14,788	15,751	-6.51%	25%	27%
Aug-06	31	8.39	9,540	10,160	-6.50%	16%	17%
Sep-06	30	9.58	14,440	13,655	5.44%	25%	24%
Oct-06	31	9.95	16,569	16,130	2.65%	28%	27%
Nov-06	30	9.78	18,392	15,250	17.08%	32%	27%
Dec-06	31	9.47	13,269	15,059	-13.49%	22%	26%
Total	365		196,732	196,735	0.00%	28%	28%
Total in OSP (07/15-09/15)	63	8.90	23,230	23,230	0.00%	19%	19%

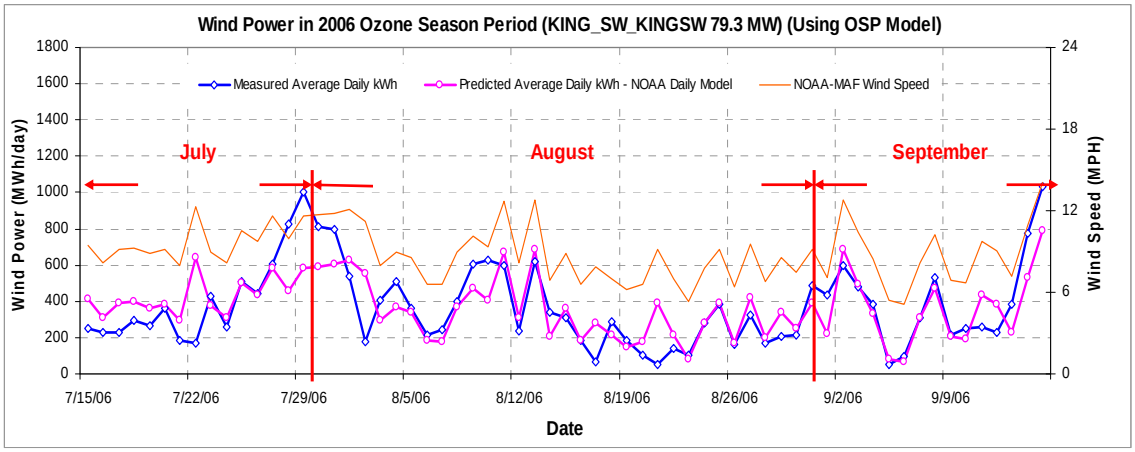

Figure 12-55: KING_SW_KINGSW – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

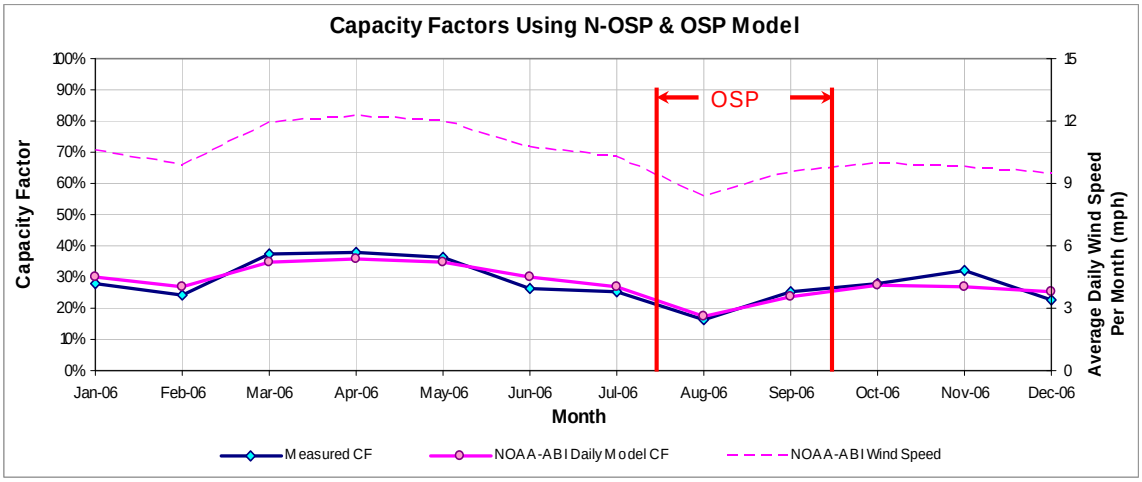

Figure 12-56: KING_SW_KINGSW - Predicted Capacity Factors Using Daily Models (2006).

Table 12-55: KING_SW_KINGSW – Predicted Power Production in 1999

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	2006 Measured MWh/yr for Modeling	1999 OSD Estimated MWh/day (2006 Daily Model)	2006 OSD Measured MWh/day for Modeling
210,137	196,732	415	369

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.13 Red Canyon

Table 12-56: Site Information for Red Canyon 1.

GENSITECODE_ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Interconnection	Weather Station
Red Canyon	WIND		BORDEN	Apr-06	84	FPL Energy	Red Canyon1		ERCOT		BEPC	ABI

SUBGENCODE_ERCOT	GENSITECODE_ERCOT	Capacity (MW)
Red Canyon 1	Red Canyon	84

12.13.1 Red Canyon 1 – RDCANYON_RDCNY1

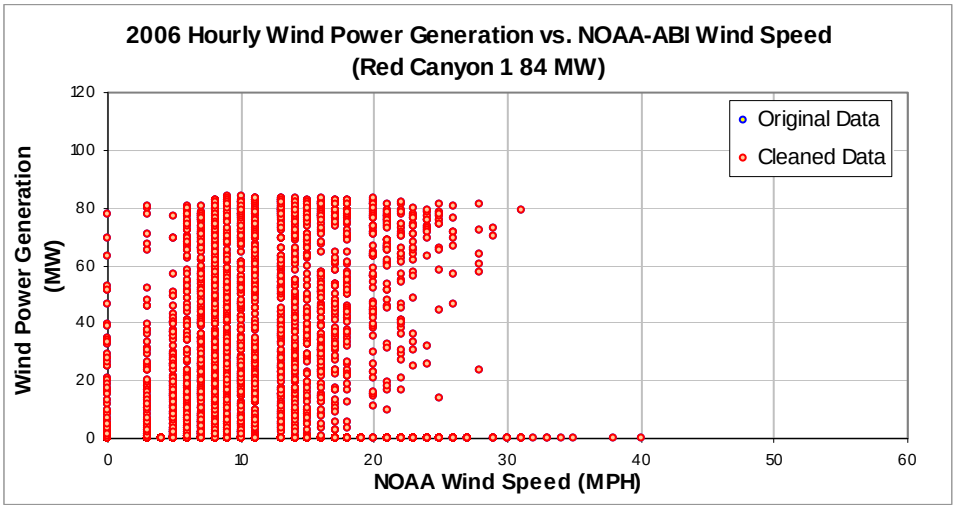

Figure 12-57: RDCANYON_RDCNY1 – Hourly Wind Power vs. NOAA Wind Speed (2006).

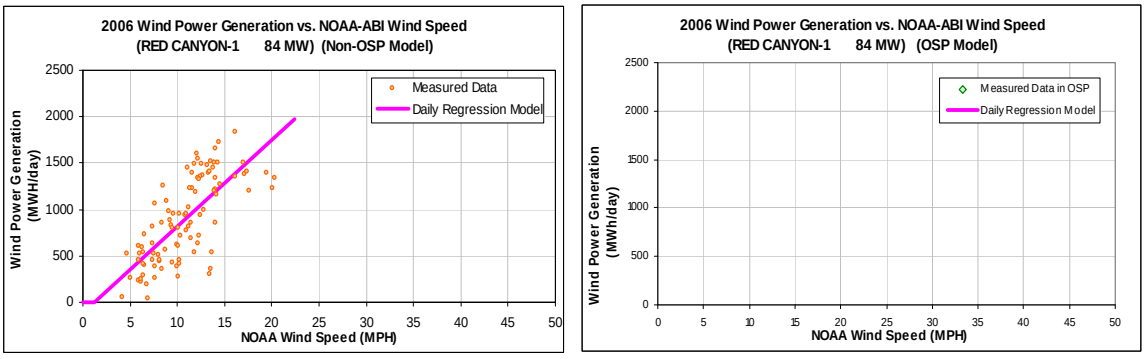

Figure 12-58: RDCANYON_RDCNY1 – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Note: Due to the missing data in the Ozone Season Period, there is no model for the OSD.

Table 12-57: RDCANYON_RDCNY1 – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-116.8730
Left Slope (MWh/mph-day)	93.095
RMSE (MWh/day)	315.2
R2	0.5226
CV-RMSE	35.2%

Table 12-58: RDCANYON_RDCNY1 – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	0	N/A	0	0	N/A	N/A	N/A
Feb-06	0	N/A	0	0	N/A	N/A	N/A
Mar-06	0	N/A	0	0	N/A	N/A	N/A
Apr-06	0	N/A	0	0	N/A	N/A	N/A
May-06	0	N/A	0	0	N/A	N/A	N/A
Jun-06	0	N/A	0	0	N/A	N/A	N/A
Jul-06	0	N/A	0	0	N/A	N/A	N/A
Aug-06	0	N/A	0	0	N/A	N/A	N/A
Sep-06	10	10.82	8,287	8,905	-7.46%	41%	44%
Oct-06	31	10.68	27,276	27,213	0.23%	44%	44%
Nov-06	27	11.17	24,815	24,915	-0.41%	46%	46%
Dec-06	31	10.81	28,231	27,575	2.32%	45%	44%
Total	99	10.87	88,609	88,609	0.00%	44%	44%
Total in OSP (07/15-09/15)	0	N/A	0	0	N/A	N/A	N/A

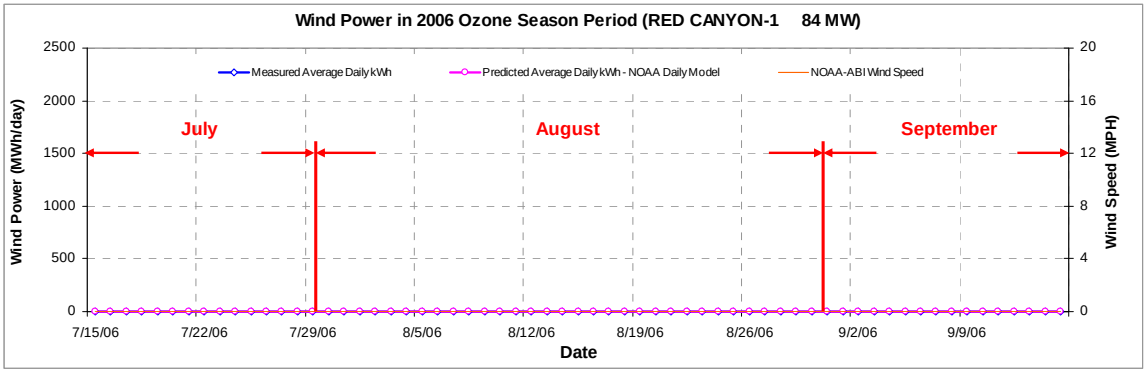

Figure 12-59: RDCANYON_RDCNY1 – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

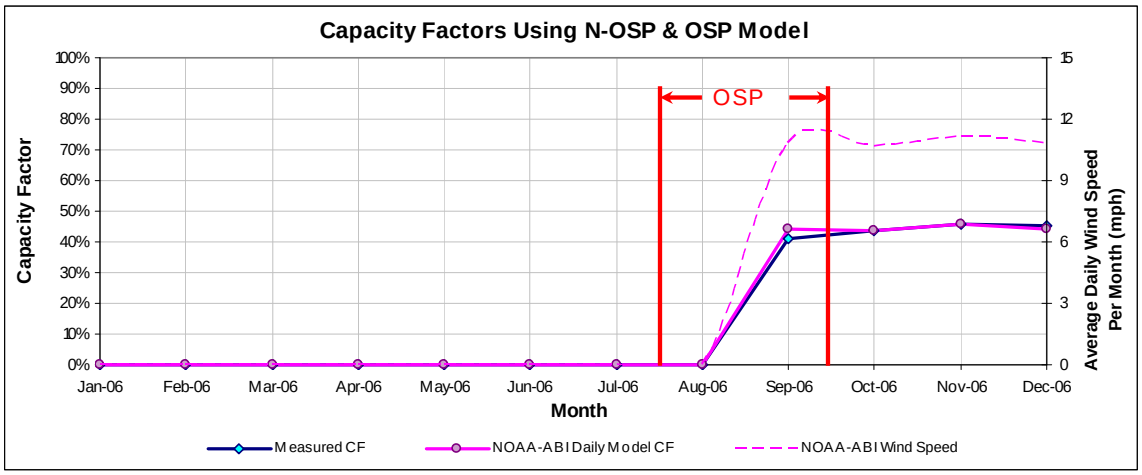

Figure 12-60: RDCANYON_RDCNY1 – Predicted Capacity Factors Using Daily Models (2006).

Table 12-59: RDCANYON_RDCNY1 – Predicted Power Production in 1999.

Annual

1999 Estimated MWh/yr (2006 Daily Model)	2006 Measured MWh/yr for Modeling
341,043	326,689

OSD

1999 OSD Estimated MWh/day (2006 Daily Model)	2006 OSD Measured MWh/day for Modeling
787	N/A

1999 (Apr-Dec) Estimated MWh/yr (2006 Daily Model)	2006 (Apr-Dec) Measured MWh/yr
250,818	246,135

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.14 Sweetwater Wind 2

Table 12-60: Site Information for Sweetwater Wind 2.

GENSITECODE_ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Intercon-nection	Weather Station
SWEETWN2	WIND	Sweetwater	NOLAN	Feb-05	91.5	DKRW Development	Sweetwater Wind 2	GE Wind 1500 (61)	ERCOT	TXU	TXU	ABI

SUBGENCODE_ERCOT	GENSITECODE_ERCOT	Capacity (MW)
SWEETWN2_WND2	SWEETWN2	91.5

12.14.1 Sweetwater Wind 2 – SWEETWN2_WND2

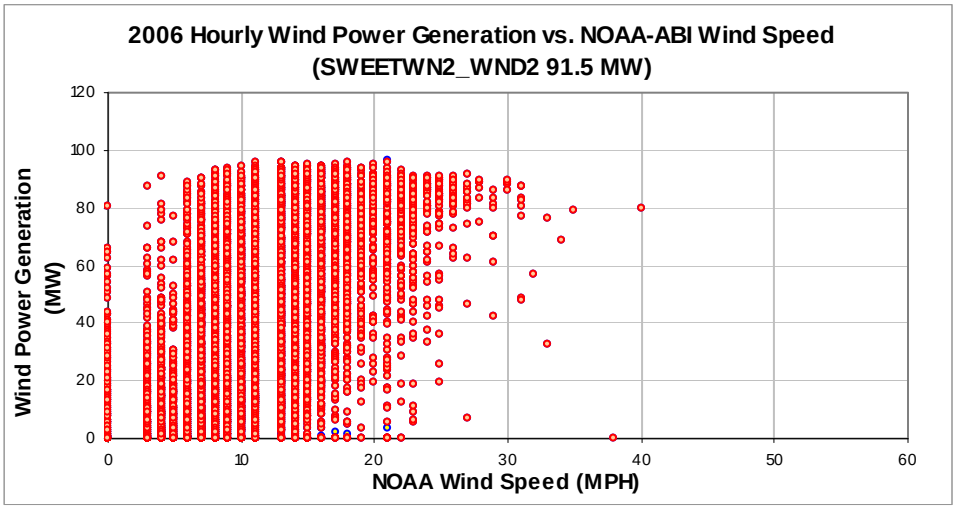

Figure 12-61: SWEETWN2_WND2 – Hourly Wind Power vs. NOAA Wind Speed (2006).

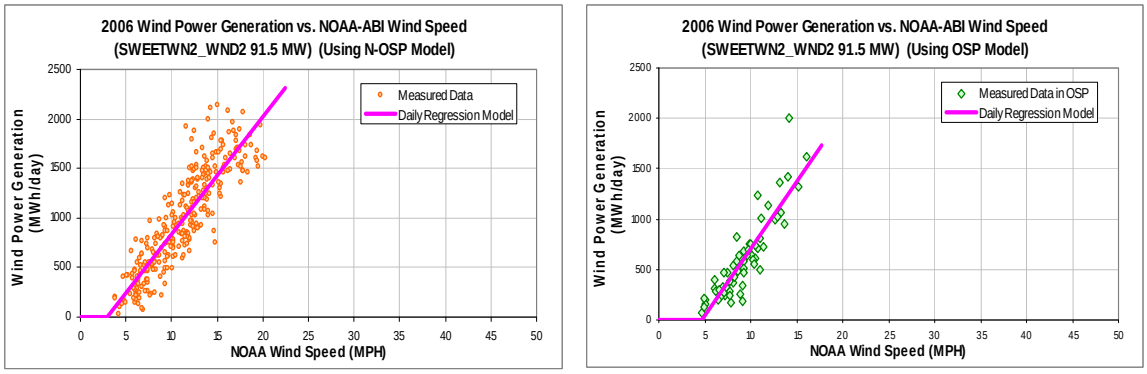

Figure 12-62: SWEETWN2_WND2 – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-61: SWEETWN2_WND2 – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-343.07
Left Slope (MWh/mph-day)	118.56
RMSE (MWh/day)	242.57
R2	0.77
CV-RMSE	24.28%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-624.9461
Left Slope (MWh/mph-day)	133.253
RMSE (MWh/day)	186.218
R2	0.7890
CV-RMSE	30.7%

Table 12-62: SWEETWN2_WND2 – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	31	11.88	33,947	33,032	2.70%	50%	49%
Feb-06	28	11.14	26,459	27,372	-3.45%	43%	45%
Mar-06	31	12.60	32,778	35,675	-8.84%	48%	52%
Apr-06	30	12.27	32,702	33,353	-1.99%	50%	51%
May-06	31	12.32	35,372	34,640	2.07%	52%	51%
Jun-06	29	9.60	20,247	23,068	-13.93%	32%	36%
Jul-06	31	10.15	23,769	24,435	-2.80%	35%	36%
Aug-06	28	9.33	14,997	17,314	-15.45%	24%	28%
Sep-06	30	9.46	23,030	20,881	9.33%	35%	32%
Oct-06	31	10.68	29,847	28,637	4.06%	44%	42%
Nov-06	29	10.95	32,436	27,689	14.64%	51%	43%
Dec-06	25	10.99	24,513	24,003	2.08%	45%	44%
Total	354		330,098	330,098	0.00%	42%	42%
Total in OSP (07/15-09/15)	60	9.24	36,383	36,383	0.00%	28%	28%

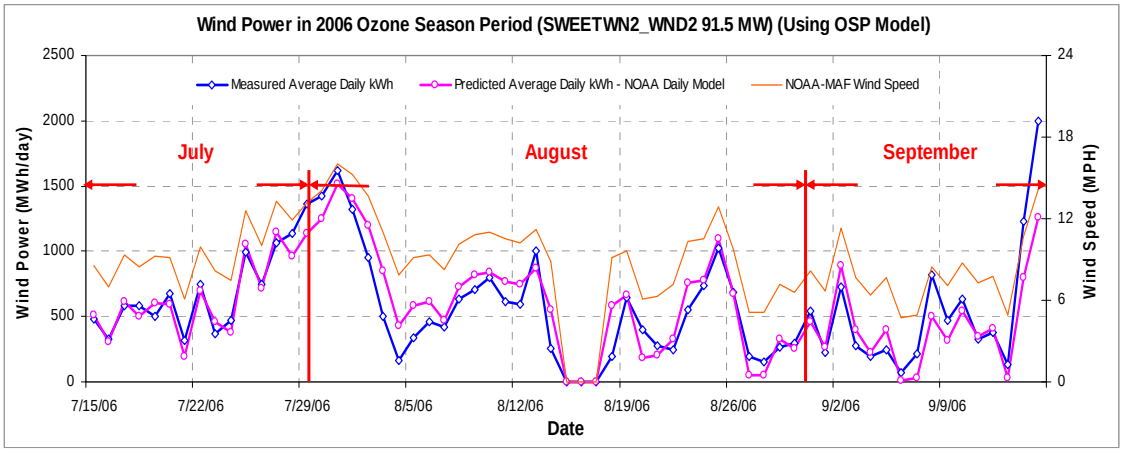

Figure 12-63: SWEETWN2_WND2 – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

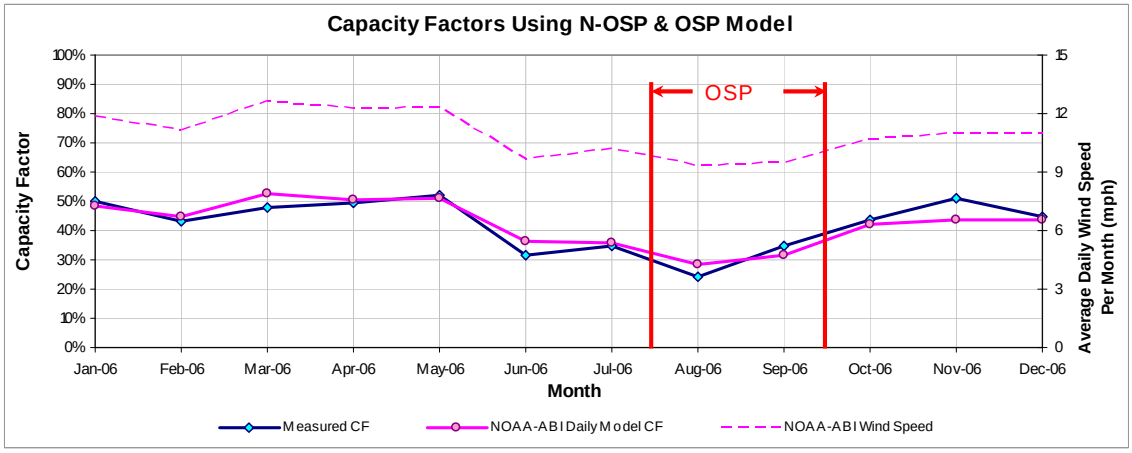

Figure 12-64: SWEETWN2_WND2 – Predicted Capacity Factors Using Daily Models (2006).

Table 12-63: SWEETWN2_WND2 – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	2006 Measured MWh/yr for Modeling	1999 OSD Estimated MWh/day (2006 Daily Model)	2006 OSD Measured MWh/day for Modeling
354,718	340,355	669	606

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.15 Sweetwater Wind 3

Table 12-64: Site Information for Sweetwater Wind 3.

GENSITECODE_ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Interconnection	Weather Station
SWEETWN3	WIND	Sweetwater	NOLAN	Feb-05	135	DKRW Development	Sweetwater Wind 3	GE Wind 1500 (61)	ERCOT	TXU	TXU	ABI

SUBGENCODE_ERCOT	GENSITECODE_ERCOT	Capacity (MW)
SWEETWN3_WND3	SWEETWN3	135

12.15.1 Sweetwater Wind 3 – SWEETWN3_WND3

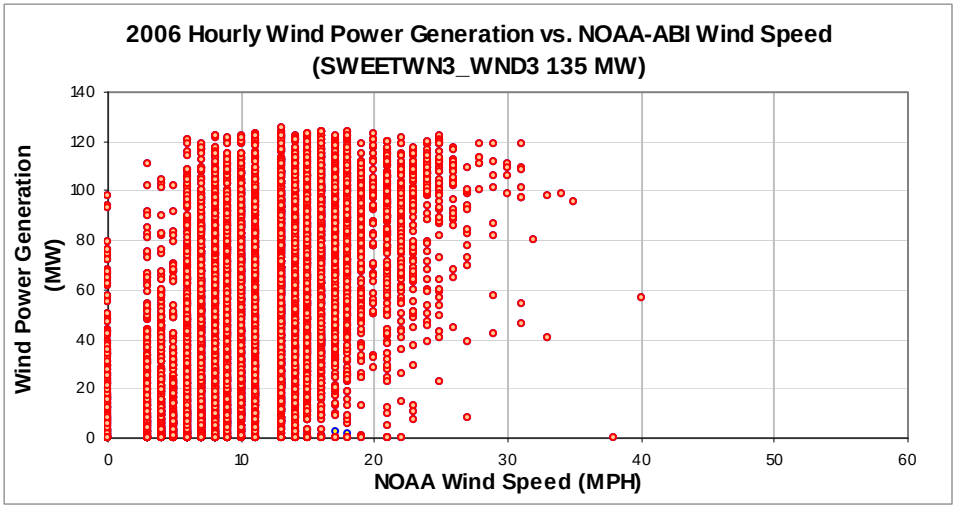

Figure 12-65: SWEETWN3_WND3 – Hourly Wind Power vs. NOAA Wind Speed (2006).

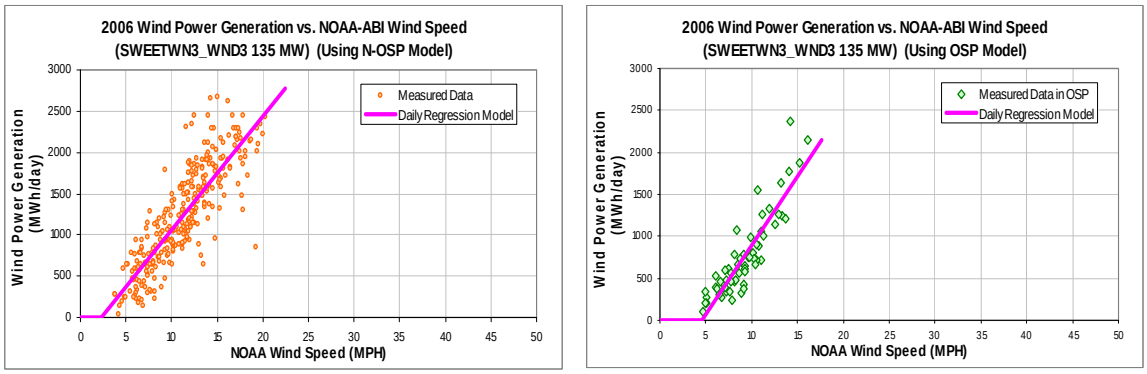

Figure 12-66: SWEETWN3_WND3 – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-65: SWEETWN3_WND3 – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-321.41
Left Slope (MWh/mph-day)	138.59
RMSE (MWh/day)	324.1
R2	0.72
CV-RMSE	25.95%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-735.99
Left Slope (MWh/mph-day)	162.65
RMSE (MWh/day)	224.056
R2	0.7937
CV-RMSE	29.2%

Table 12-66: SWEETWN3_WND3 – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	31	11.88	34,836	41,081	-17.93%	35%	41%
Feb-06	28	11.14	33,273	34,226	-2.86%	37%	38%
Mar-06	31	12.60	40,682	44,171	-8.57%	41%	44%
Apr-06	30	12.27	39,921	41,377	-3.65%	41%	43%
May-06	31	12.32	44,001	42,961	2.37%	44%	43%
Jun-06	29	9.60	26,630	29,274	-9.93%	28%	31%
Jul-06	31	10.15	28,497	30,786	-8.03%	28%	31%
Aug-06	28	9.33	19,383	21,883	-12.90%	21%	24%
Sep-06	30	9.46	29,729	26,337	11.41%	31%	27%
Oct-06	31	10.68	38,728	35,943	7.19%	39%	36%
Nov-06	29	10.95	42,613	34,676	18.63%	45%	37%
Dec-06	27	11.12	37,359	32,938	11.83%	43%	38%
Total	356		415,652	415,652	0.00%	36%	36%
Total in OSP (07/15-09/15)	60	9.24	46,015	46,015	0.00%	24%	24%

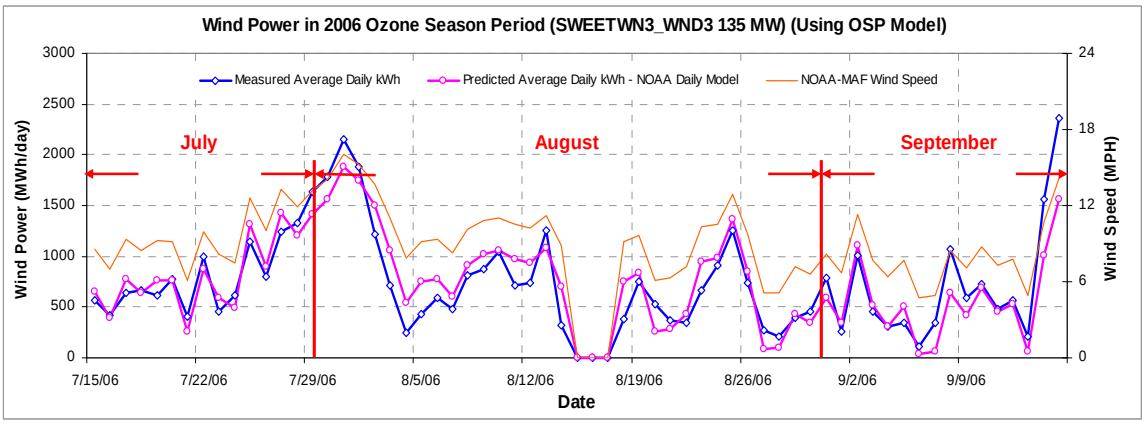

Figure 12-67: SWEETWN3_WND3 – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

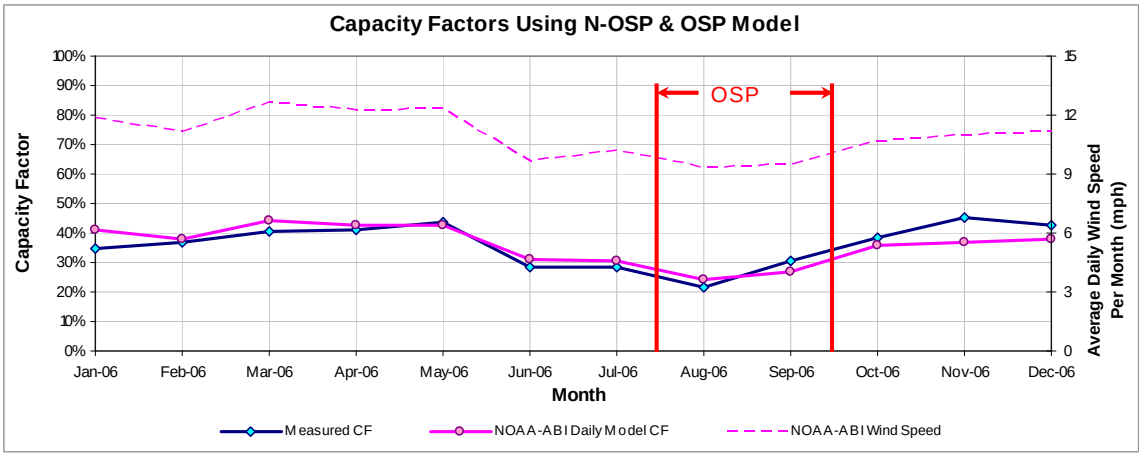

Figure 12-68: SWEETWN3_WND3 – Predicted Capacity Factors Using Daily Models (2006).

Table 12-67: SWEETWN3_WND3 – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	2006 Measured MWh/yr for Modeling	1999 OSD Estimated MWh/day (2006 Daily Model)	2006 OSD Measured MWh/day for Modeling
442,506	426,160	843	767

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.16 Sweetwater Wind 1

Table 12-68: Site Information for Sweetwater Wind 1.

GENSITECODE_ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Interconnection	Weather Station
SWEETWND	WIND	Sweetwater	NOLAN	Dec-03	37.5	DKR Development	Sweetwater Wind 1	GE Wind 1500 (25)	ERCOT	LCRA	LCRA	ABI

SUBGENCODE_ERCOT	GENSITECODE_ERCOT	Capacity (MW)
SWEETWND_WND1	SWEETWND	37.5

12.16.1 Sweetwater Wind 1 – SWEETWND_WND1

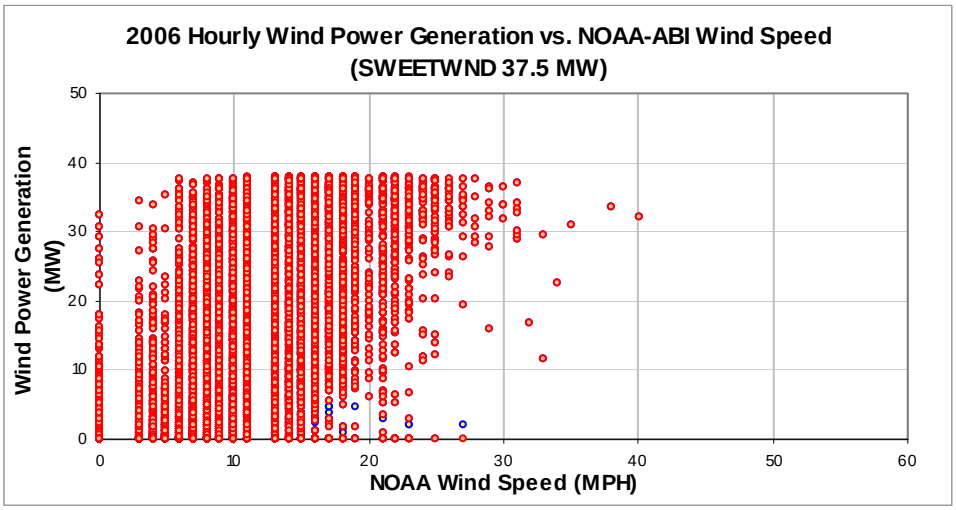

Figure 12-69: SWEETWND_WND1 – Hourly Wind Power vs. NOAA Wind Speed (2006).

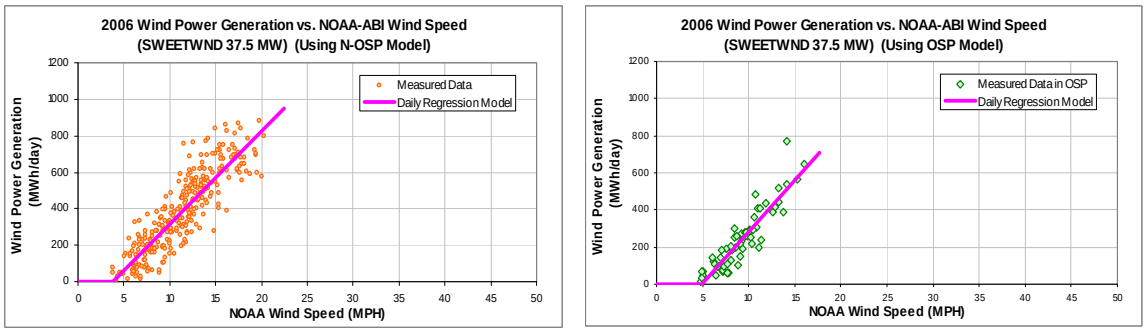

Figure 12-70: SWEETWND_WND1 – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-69: SWEETWND_WND1 – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-191.15
Left Slope (MWh/mph-day)	50.87
RMSE (MWh/day)	104.24
R2	0.77
CV-RMSE	27.12%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-272.06
Left Slope (MWh/mph-day)	55.622
RMSE (MWh/day)	69.453
R2	0.824
CV-RMSE	28.7%

Table 12-70: SWEETWND_WND1 – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	31	11.88	13,257	12,809	3.38%	48%	46%
Feb-06	28	11.14	10,678	10,512	1.55%	42%	42%
Mar-06	31	12.60	12,929	13,943	-7.84%	46%	50%
Apr-06	29	12.19	12,045	12,437	-3.26%	46%	48%
May-06	31	12.32	12,444	13,499	-8.48%	45%	48%
Jun-06	30	9.83	8,793	9,260	-5.31%	33%	34%
Jul-06	31	10.15	9,338	9,530	-2.06%	33%	34%
Aug-06	28	9.33	6,383	6,914	-8.31%	25%	27%
Sep-06	30	9.46	8,668	8,065	6.95%	32%	30%
Oct-06	31	10.68	11,139	10,923	1.94%	40%	39%
Nov-06	27	10.79	10,896	9,652	11.42%	45%	40%
Dec-06	26	11.03	10,580	9,614	9.13%	45%	41%
Total	353	10.95	127,149	127,158	-0.01%	40%	40%
Total in OSP (07/15-09/15)	60	9.24	14,515	14,523	-0.06%	27%	27%

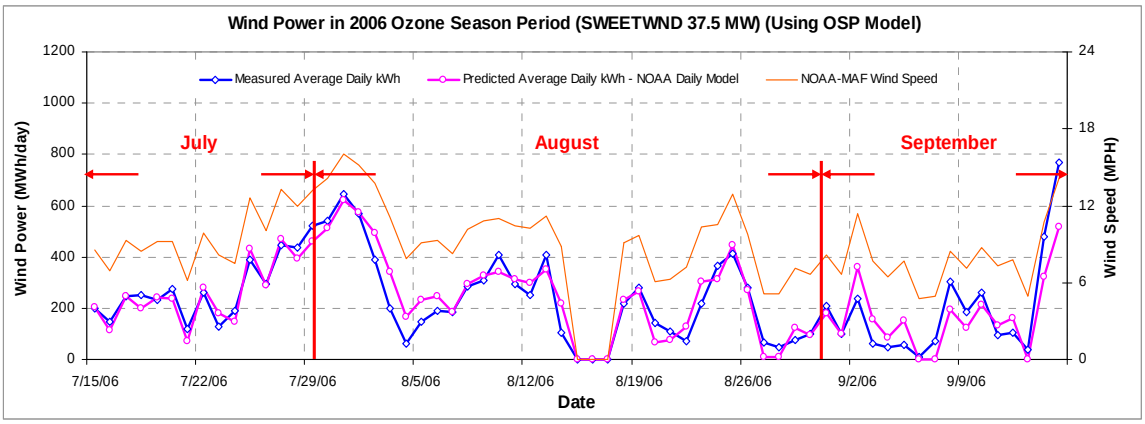

Figure 12-71: SWEETWND_WND1 – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

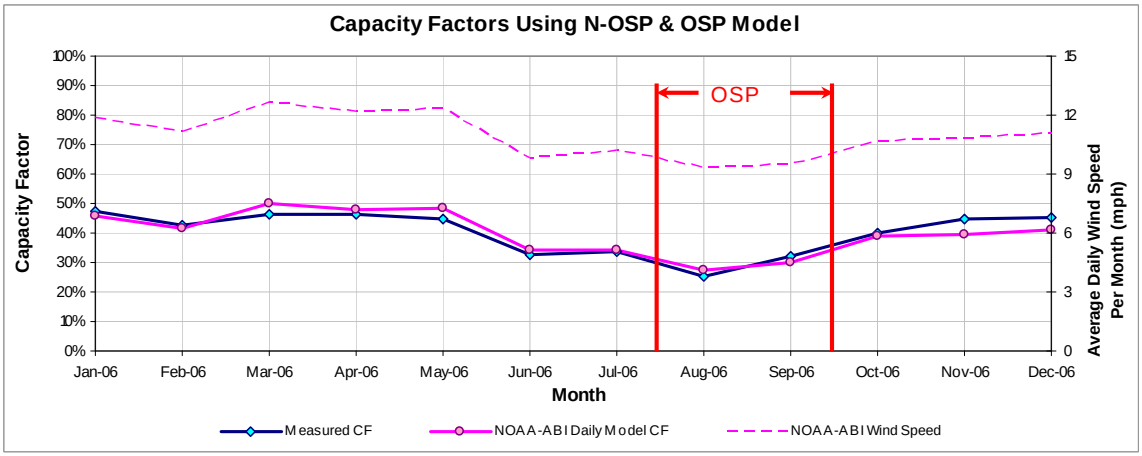

Figure 12-72: SWEETWND_WND1 – Predicted Capacity Factors Using Daily Models (2006).

Table 12-71: SWEETWND_WND1 – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	2006 Measured MWh/yr for Modeling	1999 OSD Estimated MWh/day (2006 Daily Model)	2006 OSD Measured MWh/day for Modeling
137,761	131,472	268	242

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.17 Trent Mesa

Table 12-72: Site Information for Trent Mesa.

GENSITECODE_ ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Intercon-nection	Weather Station
TRENT	WIND	Trent Mesa	NOLAN	Nov-01	150	AEP	Trent Mesa	Enron 1500 (100)	ERCOT	TXU	TXU	ABI

SUBGENCODE_ ERCOT	GENSITECOD E_ERCOT	Capacity (MW)
TRENT_TRENT	TRENT	150

12.17.1 Trent Mesa – TRENT_TRENT

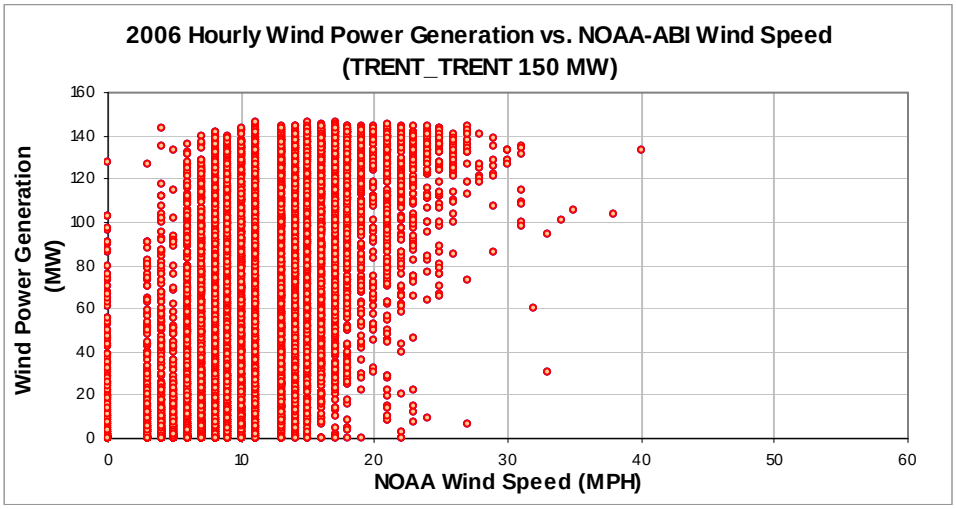

Figure 12-73: TRENT_TRENT – Hourly Wind Power vs. NOAA Wind Speed (2006).

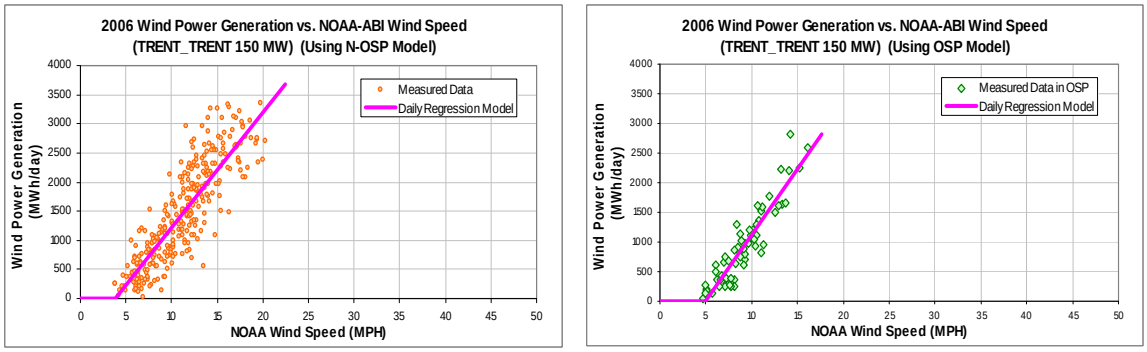

Figure 12-74: TRENT_TRENT – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-73: TRENT_TRENT – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-758.44
Left Slope (MWh/mph-day)	198.46
RMSE (MWh/day)	434.5
R2	0.74
CV-RMSE	29.23%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-1087.79
Left Slope (MWh/mph-day)	220.61
RMSE (MWh/day)	252.23
R2	0.8457
CV-RMSE	27.0%

Table 12-74: TRENT_TRENT – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	31	11.88	55,323	49,581	10.38%	50%	44%
Feb-06	28	11.14	39,967	40,660	-1.73%	40%	40%
Mar-06	31	12.60	48,230	54,006	-11.98%	43%	48%
Apr-06	30	12.27	47,942	50,303	-4.92%	44%	47%
May-06	31	12.32	50,609	52,273	-3.29%	45%	47%
Jun-06	30	9.83	33,087	35,747	-8.04%	31%	33%
Jul-06	31	10.15	36,791	37,186	-1.07%	33%	33%
Aug-06	31	9.16	26,942	28,890	-7.23%	24%	26%
Sep-06	30	9.46	33,363	31,327	6.10%	31%	29%
Oct-06	31	10.68	44,044	42,224	4.13%	39%	38%
Nov-06	29	10.95	46,368	41,006	11.56%	44%	39%
Dec-06	31	10.81	43,481	42,996	1.12%	39%	39%
Total	364		506,147	506,199	-0.01%	39%	39%
Total in OSP (07/15-09/15)	63	9.16	58,757	58,809	-0.09%	26%	26%

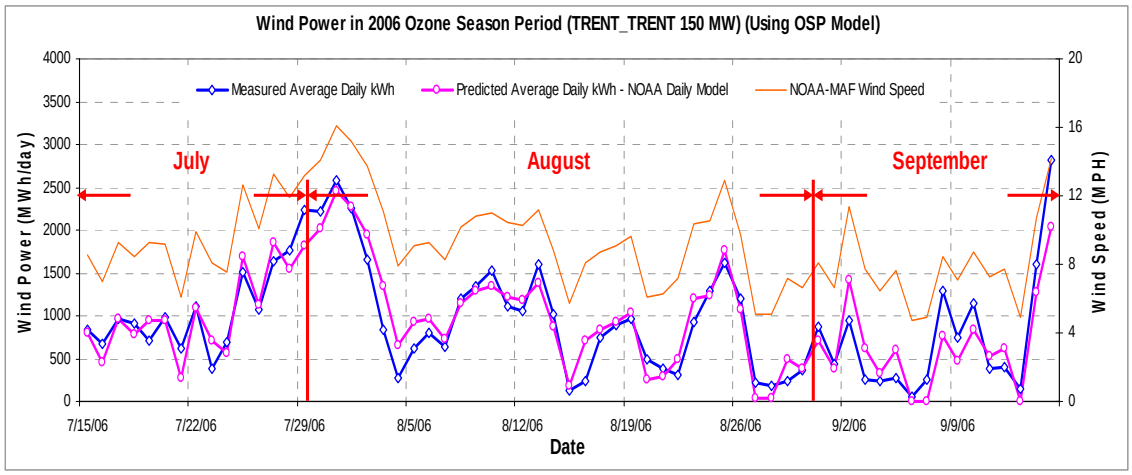

Figure 12-75: TRENT_TRENT – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

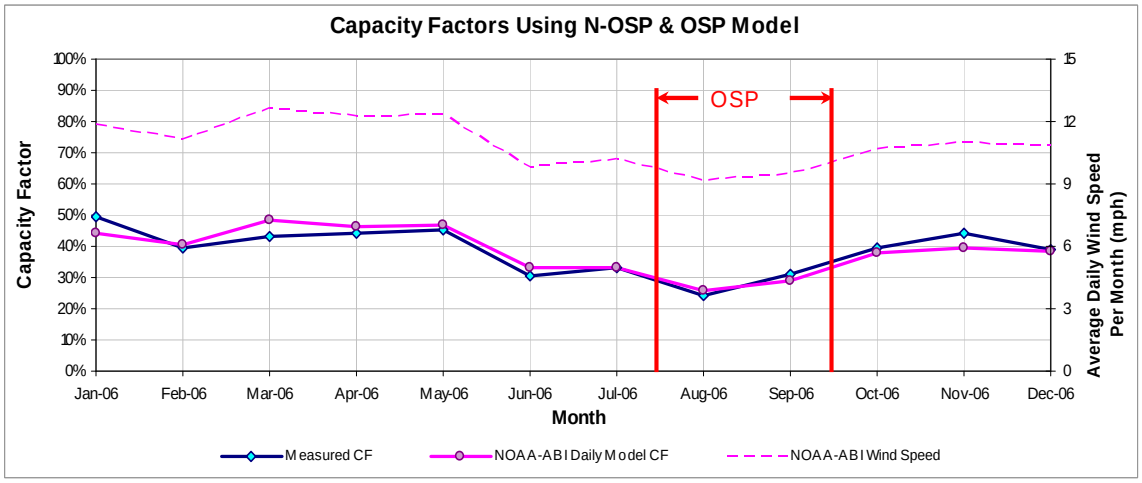

Figure 12-76: TRENT_TRENT – Predicted Capacity Factors Using Daily Models (2006).

Table 12-75: TRENT_TRENT – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	**2006 Measured MWh/yr for Modeling**	**1999 OSD Estimated MWh/day (2006 Daily Model)**	**2006 OSD Measured MWh/day for Modeling**
534,218	**507,538**	**1,054**	**933**

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.18 Delaware Mountain Wind Farm

Table 12-76: Site Information for Delaware Mountain Wind Farm.

GENSITECODE _ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Intercon-nection	Weather Station
DELAWARE	WIND		CULBERSON	Jun-99	30	American National Wind Power	Delaware Mountain Wind Farm	Zond (40)	ERCOT	TXU	TXU	GDP

SUBGENCODE _ERCOT	GENSITECODE _ERCOT	Capacity (MW)
DELAWARE_WIND_NWP	DELAWARE	30

12.18.1 Delaware Mountain – DELAWARE_WIND_NWP

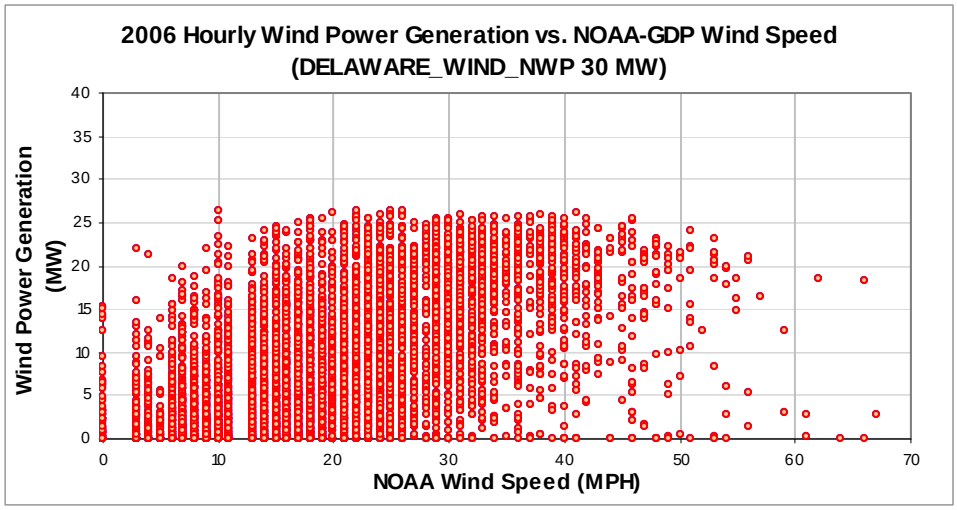

Figure 12-77: DELAWARE_WIND_NWP – Hourly Wind Power vs. NOAA Wind Speed (2006).

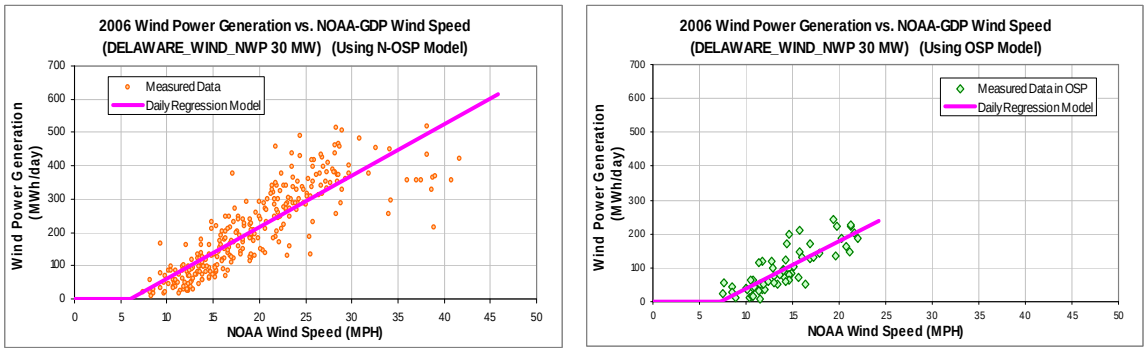

Figure 12-78: DELAWARE_WIND_NWP – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-77: DELAWARE_WIND_NWP – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-93.97
Left Slope (MWh/mph-day)	15.46
RMSE (MWh/day)	66.88
R2	0.720.74
CV-RMSE	32.33%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-101.886
Left Slope (MWh/mph-day)	14.042
RMSE (MWh/day)	35.938
R2	0.688
CV-RMSE	37.1%

Table 12-78: DELAWARE_WIND_NWP – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	31	22.39	8,527	7,822	8.27%	38%	35%
Feb-06	28	21.17	6,307	6,534	-3.60%	31%	32%
Mar-06	31	23.65	7,123	8,427	-18.30%	32%	38%
Apr-06	30	22.25	7,383	7,502	-1.61%	34%	35%
May-06	31	17.14	5,023	5,303	-5.56%	23%	24%
Jun-06	28	14.85	3,781	3,798	-0.46%	19%	19%
Jul-06	31	14.07	3,532	3,355	5.02%	16%	15%
Aug-06	29	13.63	2,315	2,598	-12.19%	11%	12%
Sep-06	28	15.53	3,154	3,650	-15.74%	16%	18%
Oct-06	31	17.15	5,819	5,306	8.80%	26%	24%
Nov-06	30	19.65	7,001	6,299	10.02%	32%	29%
Dec-06	27	20.78	6,767	6,138	9.29%	35%	32%
Total	355		66,731	66,731	0.00%	26%	26%
Total in OSP (07/15-09/15)	61	14.15	5,904	5,904	0.00%	13%	13%

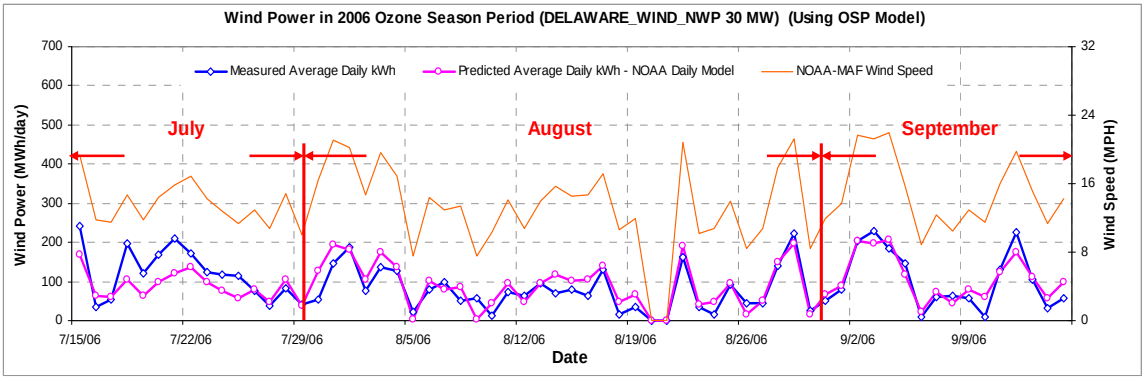

Figure 12-79: DELAWARE_WIND_NWP – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

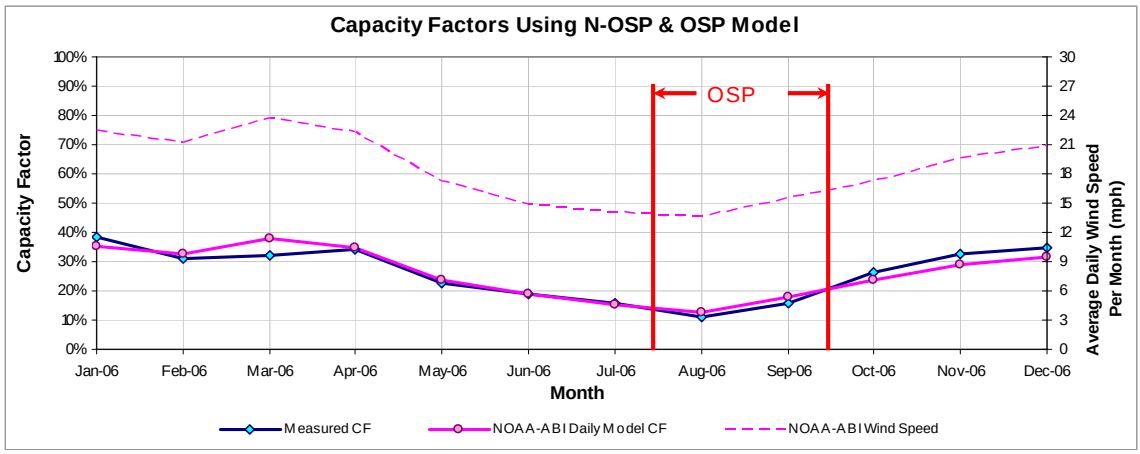

Figure 12-80: DELAWARE_WIND_NWP – Predicted Capacity Factors Using Daily Models (2006).

Table 12-79: DELAWARE_WIND_NWP – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	**2006 Measured MWh/yr for Modeling**	**1999 OSD Estimated MWh/day (2006 Daily Model)**	**2006 OSD Measured MWh/day for Modeling**
67,452	**68,611**	**93**	**97**

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.19 Indian Mesa

Table 12-80: Site Information for Indian Mesa.

GENSITECODE_ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Intercon-nection	Weather Station
INDNNWP	WIND	Iraan	PECOS	Jun-01	82.5	Orion Energy/American National Wind Power	Indian Mesa I	Vestas V-47 (125)	ERCOT	AEP-West	WTU	FST

SUBGENCODE_ERCOT	GENSITECODE_ERCOT	Capacity (MW)
INDNNWP_INDNNWP_J01	INDNNWP	50.3
INDNNWP_INDNNWP_J02	INDNNWP	32.2

12.19.1 Indian Mesa – INDNNWP_INDNNWP

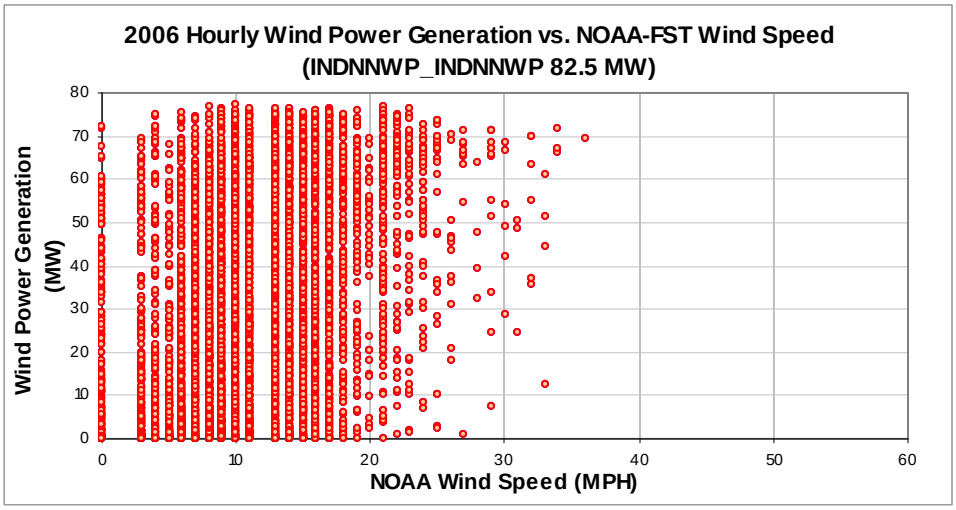

Figure 12-81: INDNNWP_INDNNWP- Hourly Wind Power vs. NOAA Wind Speed (2006).

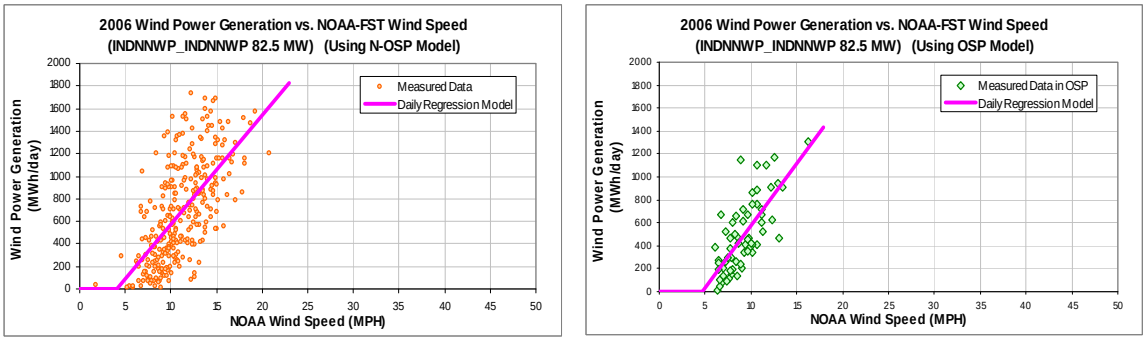

Figure 12-82: INDNNWP_INDNNWP – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-81: INDNNWP_INDNNWP – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-392.43
Left Slope (MWh/mph-day)	96.66
RMSE (MWh/day)	335.62
R2	0.41
CV-RMSE	49.19%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-508.3592
Left Slope (MWh/mph-day)	108.14
RMSE (MWh/day)	213.17
R2	0.533
CV-RMSE	43.8%

Table 12-82: INDNNWP_INDNNWP – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	29	11.08	19,122	19,902	-4.08%	33%	35%
Feb-06	28	10.24	16,441	16,713	-1.66%	30%	30%
Mar-06	31	11.75	24,082	23,042	4.32%	39%	38%
Apr-06	30	12.12	23,636	23,385	1.06%	40%	39%
May-06	31	12.32	27,678	24,758	10.55%	45%	40%
Jun-06	30	11.07	18,386	20,334	-10.59%	31%	34%
Jul-06	31	10.57	18,931	19,546	-3.25%	31%	32%
Aug-06	31	8.91	13,783	14,121	-2.46%	22%	23%
Sep-06	30	9.48	15,453	15,461	-0.05%	26%	26%
Oct-06	31	10.49	20,415	19,277	5.57%	33%	31%
Nov-06	30	10.99	21,386	20,100	6.01%	36%	34%
Dec-06	31	10.38	16,053	18,942	-18.00%	26%	31%
Total	363		235,365	235,581	-0.09%	33%	33%
Total in OSP (07/15-09/15)	63	9.20	30,661	30,661	0.00%	25%	25%

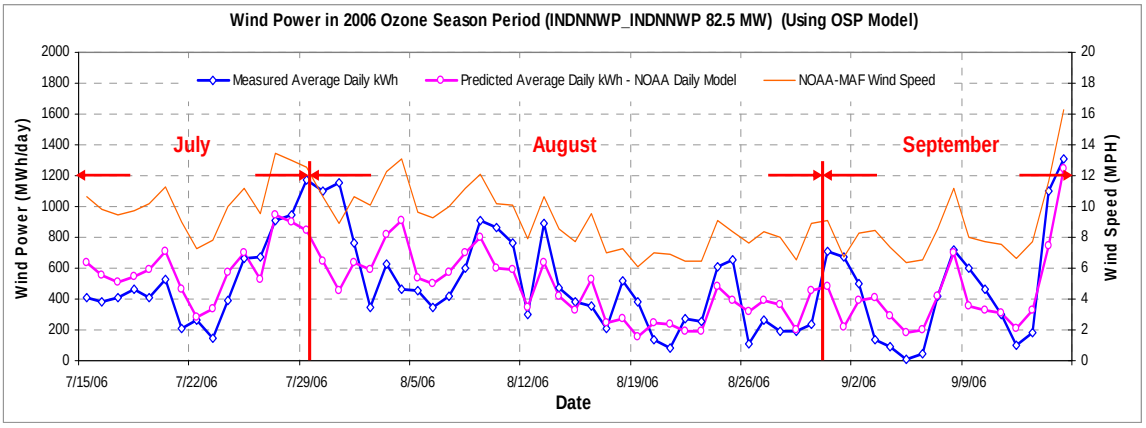

Figure 12-83: INDNNWP_INDNNWP – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

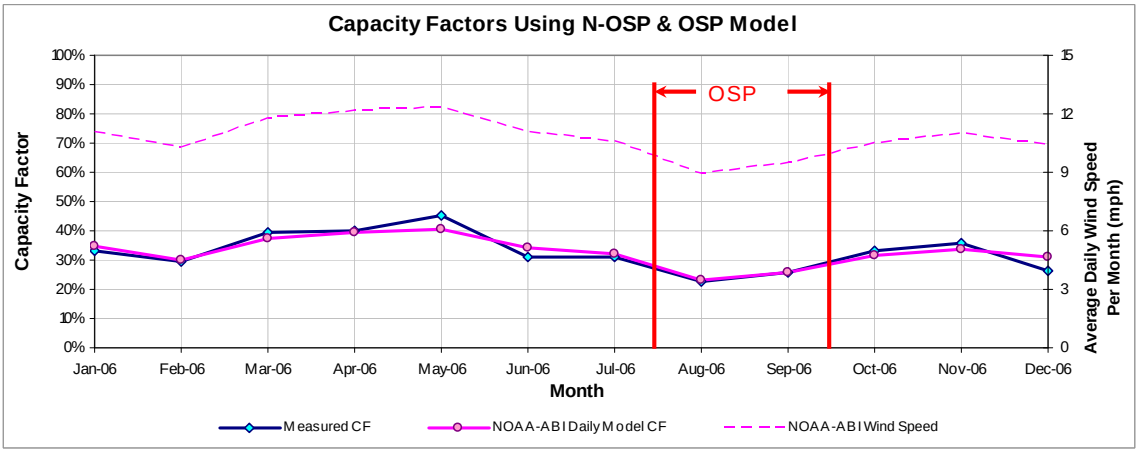

Figure 12-84: INDNNWP_INDNNWP – Predicted Capacity Factors Using Daily Models (2006).

Table 12-83: INDNNWP_INDNNWP – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	2006 Measured MWh/yr for Modeling	1999 OSD Estimated MWh/day (2006 Daily Model)	2006 OSD Measured MWh/day for Modeling
251,397	236,662	569	487

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.20 Texas Wind Power Project

Table 12-84: Site Information for Texas Wind Power Project.

GENSITECODE_ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Intercon-nection	Weather Station
KUNITZ	WIND		CULBERSON	Jan-95	35	LG&E	Texas Wind Power Project	Kenetech (112)	ERCOT	Colorado River Authority		GDP

SUBGENCODE_ERCOT	GENSITECODE_ERCOT	Capacity (MW)
KUNITZ_WIND_LGE_J01	KUNITZ	24.9
KUNITZ_WIND_LGE_J02	KUNITZ	10.1

12.20.1 Texas Wind Power Project – KUNITZ_WIND_LGE

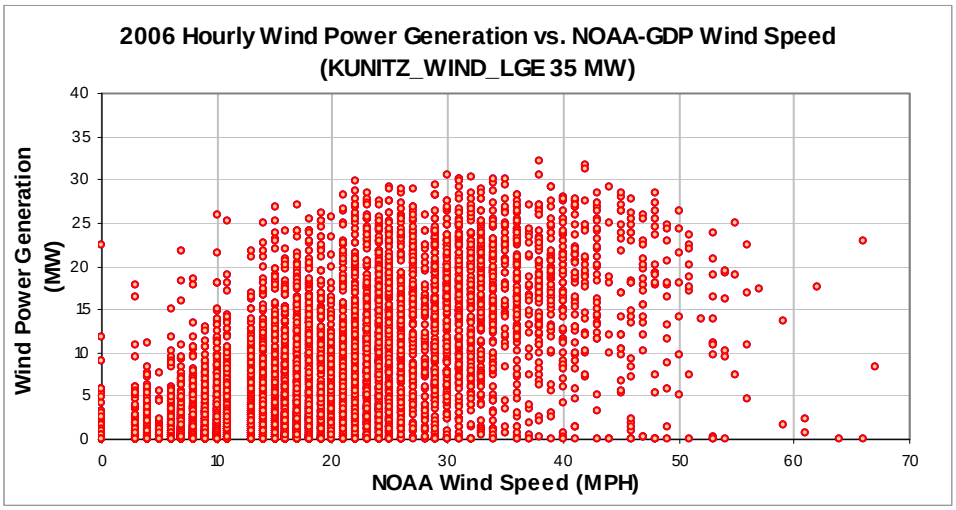

Figure 12-85: KUNITZ_WIND_LGE – Hourly Wind Power vs. NOAA Wind Speed (2006).

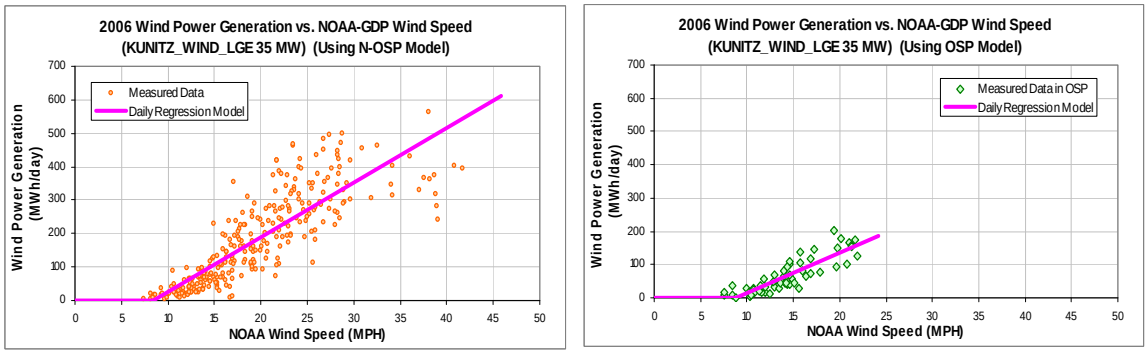

Figure 12-86: KUNITZ_WIND_LGE – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-85: KUNITZ_WIND_LGE – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-137.73
Left Slope (MWh/mph-day)	16.28
RMSE (MWh/day)	73.27
R2	0.70
CV-RMSE	41.04%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-104.588
Left Slope (MWh/mph-day)	11.9468
RMSE (MWh/day)	25.93
R2	0.754
CV-RMSE	40.2%

Table 12-86: KUNITZ_WIND_LGE – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	29	11.08	19,122	19,902	-4.08%	33%	35%
Feb-06	28	10.24	16,441	16,713	-1.66%	30%	30%
Mar-06	31	11.75	24,082	23,042	4.32%	39%	38%
Apr-06	30	12.12	23,636	23,385	1.06%	40%	39%
May-06	31	12.32	27,678	24,758	10.55%	45%	40%
Jun-06	30	11.07	18,386	20,334	-10.59%	31%	34%
Jul-06	31	10.57	18,931	19,546	-3.25%	31%	32%
Aug-06	31	8.91	13,783	14,121	-2.46%	22%	23%
Sep-06	30	9.48	15,453	15,461	-0.05%	26%	26%
Oct-06	31	10.49	20,415	19,277	5.57%	33%	31%
Nov-06	30	10.99	21,386	20,100	6.01%	36%	34%
Dec-06	31	10.38	16,053	18,942	-18.00%	26%	31%
Total	363		235,365	235,581	-0.09%	33%	33%
Total in OSP (07/15-09/15)	63	9.20	30,661	30,661	0.00%	25%	25%

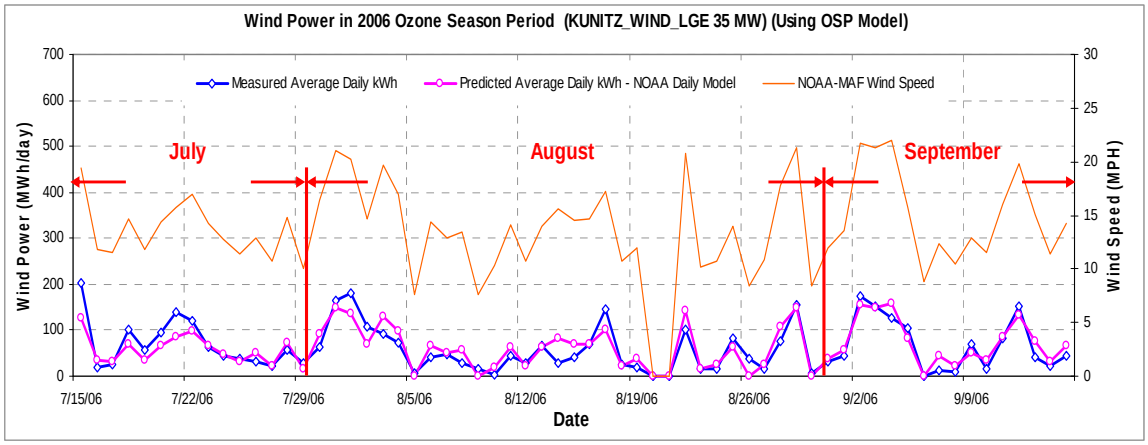

Figure 12-87: KUNITZ_WIND_LGE – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

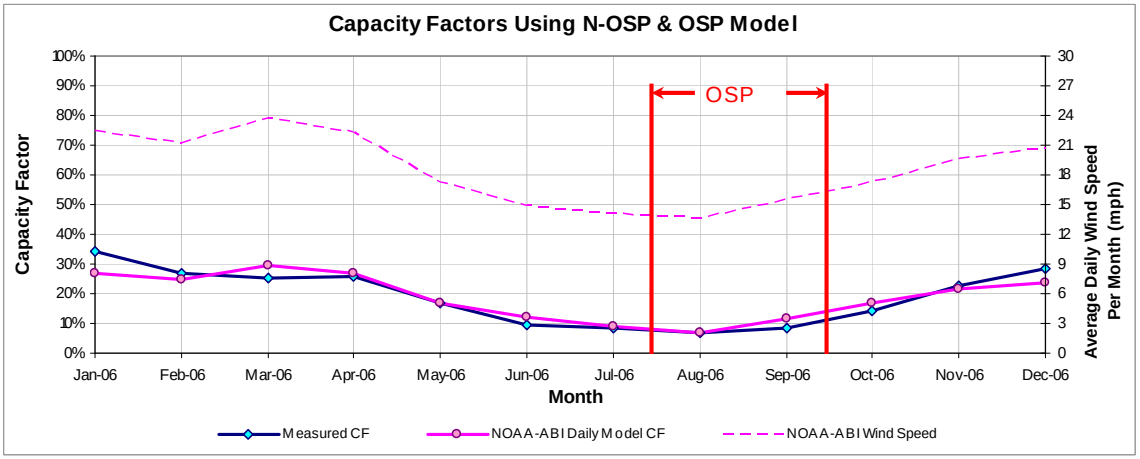

Figure 12-88: KUNITZ_WIND_LGE – Predicted Capacity Factors Using Daily Models (2006).

Table 12-87: KUNITZ_WIND_LGE – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	2006 Measured MWh/yr for Modeling	1999 OSD Estimated MWh/day (2006 Daily Model)	2006 OSD Measured MWh/day for Modeling
57,072	58,041	62	64

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.21 Big Spring Wind Power

Table 12-88: Site Information for Big Spring Wind Power.

GENSITECODE_ ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Intercon-nection	Weather Station
SGMTN	WIND	Big Spring	HOWARD	Feb-99	41	York Research	Big Spring Wind Power	Vestas V-47 (42) Vestas (4)	ERCOT	TXU	TXU	MAF

SUBGENCODE_ ERCOT	GENSITECODE_ ERCOT	Capacity (MW)
SGMTN_SIGNALMT	SGMTN	41

12.21.1 Big Spring Wind Power – SGMTN_SIGNALMT

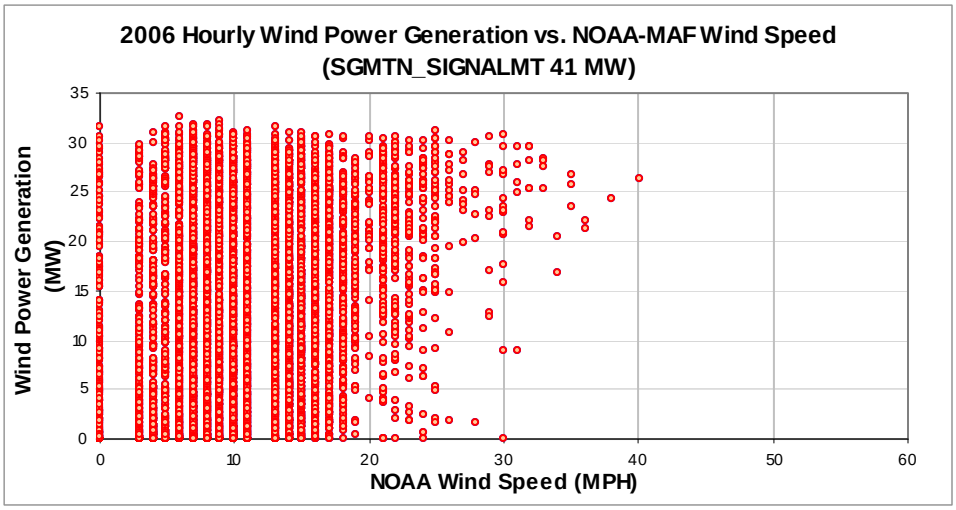

Figure 12-89: SGMTN_SIGNALMT – Hourly Wind Power vs. NOAA Wind Speed (2006).

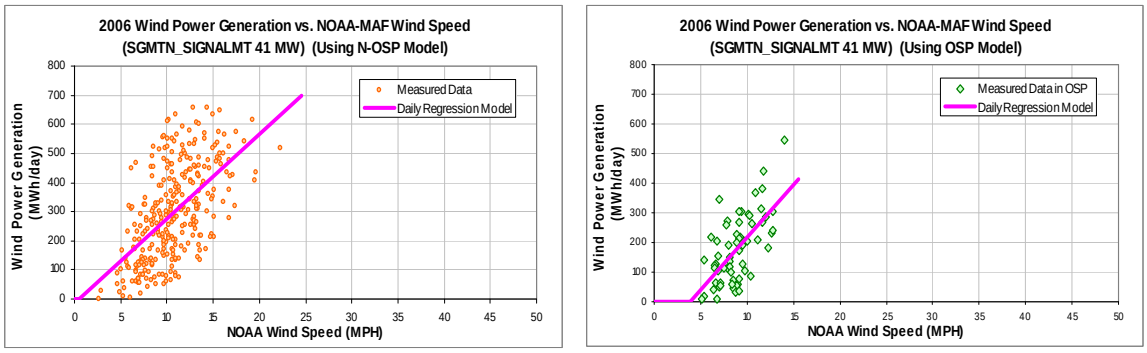

Figure 12-90: SGMTN_SIGNALMT – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-89: SGMTN_SIGNALMT – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-13.39
Left Slope (MWh/mph-day)	29.07
RMSE (MWh/day)	131.40
R2	0.33
CV-RMSE	44.08%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-138.385
Left Slope (MWh/mph-day)	35.5155
RMSE (MWh/day)	88.84
R2	0.4051
CV-RMSE	50.0%

Table 12-90: SGMTN_SIGNALMT – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	31	10.59	10,721	9,131	14.83%	35%	30%
Feb-06	28	9.89	8,195	7,674	6.36%	30%	28%
Mar-06	31	11.92	10,255	10,332	-0.75%	34%	34%
Apr-06	30	12.20	9,750	10,241	-5.04%	33%	35%
May-06	31	12.00	8,653	10,399	-20.17%	28%	34%
Jun-06	30	10.70	6,181	8,931	-44.49%	21%	30%
Jul-06	31	10.30	6,098	7,826	-28.33%	20%	26%
Aug-06	31	8.39	5,183	4,948	4.54%	17%	16%
Sep-06	30	9.58	6,927	6,931	-0.06%	23%	23%
Oct-06	31	9.95	9,049	8,555	5.46%	30%	28%
Nov-06	30	9.78	10,518	8,132	22.69%	36%	28%
Dec-06	31	9.47	9,686	8,117	16.20%	32%	27%
Total	365		101,218	101,218	0.00%	28%	28%
Total in OSP (07/15-09/15)	63	8.90	11,194	11,194	0.00%	18%	18%

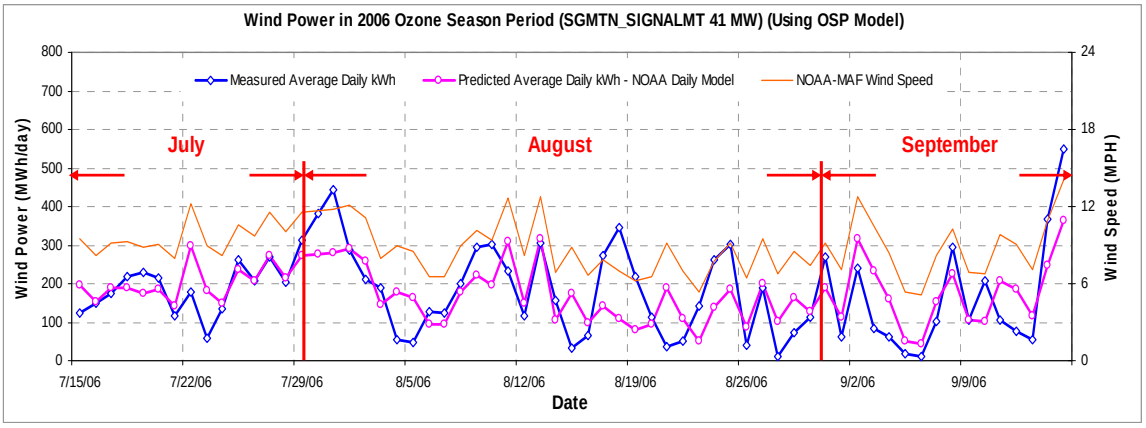

Figure 12-91: SGMTN_SIGNALMT – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

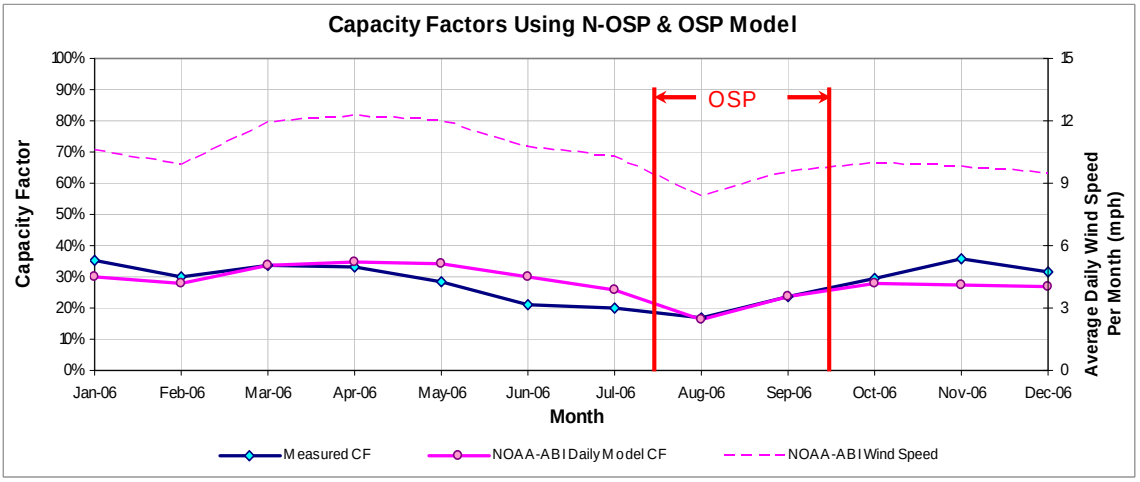

Figure 12-92: SGMTN_SIGNALMT – Predicted Capacity Factors Using Daily Models (2006).

Table 12-91: SGMTN_SIGNALMT – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	**2006 Measured MWh/yr for Modeling**	**1999 OSD Estimated MWh/day (2006 Daily Model)**	**2006 OSD Measured MWh/day for Modeling**
106,777	**101,218**	**198**	**178**

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.22 Southwest Mesa Wind Project

Table 12-92: Site Information for Southwest Mesa.

GENSITECODE_ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Intercon-nection	Weather Station
SW_MESA	WIND	McCamey	UPTON	Jun-99	75	FPL Energy	Southwest Mesa Wind Project	NEG Micon (107)	ERCOT	AEP-West	WTU	MAF

SUBGENCODE_ERCOT	GENSITECODE_ERCOT	Capacity (MW)
SW_MESA_SW_MESA	SW_MESA	75

12.22.1 Southwest Mesa Wind Project – SW_MESA_SW_MESA

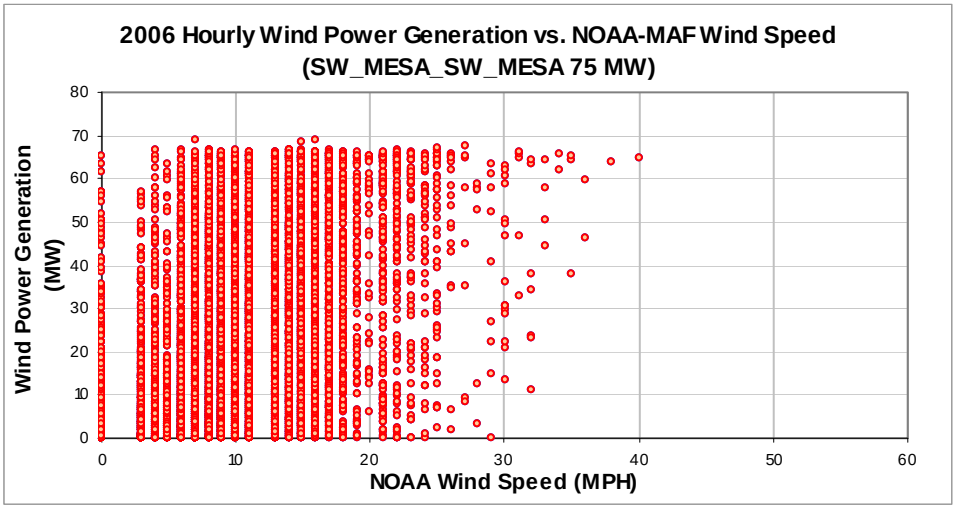

Figure 12-93: SW_MESA_SW_MESA - Hourly Wind Power vs. NOAA Wind Speed (2006).

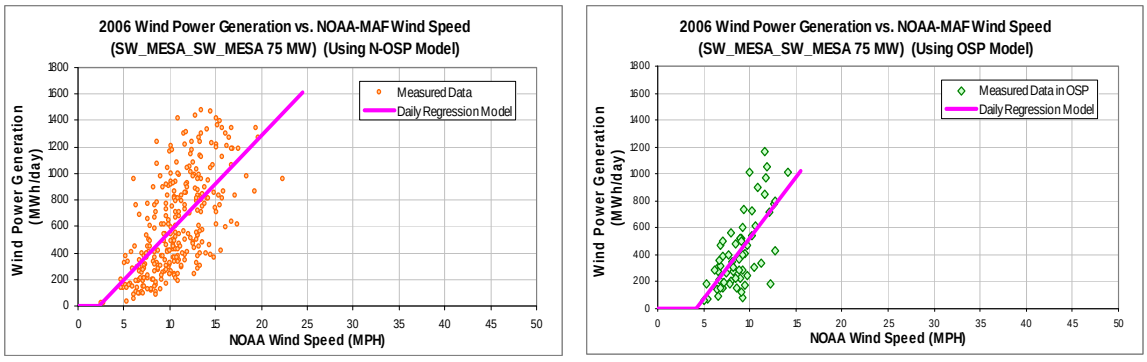

Figure 12-94: SW_MESA_SW_MESA – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-93: SW_MESA_SW_MESA – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-170.20
Left Slope (MWh/mph-day)	72.62
RMSE (MWh/day)	280.77
R2	0.41
CV-RMSE	46.19%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-378.94
Left Slope (MWh/mph-day)	90.264
RMSE (MWh/day)	202.16
R2	0.4593
CV-RMSE	47.6%

Table 12-94: SW_MESA_SW_MESA – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	31	10.59	17,381	18,570	-6.84%	31%	33%
Feb-06	28	9.89	14,696	15,341	-4.39%	29%	30%
Mar-06	31	11.92	20,804	21,569	-3.68%	37%	39%
Apr-06	30	12.20	21,387	21,480	-0.43%	40%	40%
May-06	31	12.00	24,095	21,737	9.78%	43%	39%
Jun-06	30	10.70	16,863	18,207	-7.97%	31%	34%
Jul-06	31	10.30	17,503	17,330	0.99%	31%	31%
Aug-06	31	8.39	11,822	11,732	0.76%	21%	21%
Sep-06	30	9.58	13,370	14,969	-11.96%	25%	28%
Oct-06	31	9.95	18,108	17,131	5.39%	32%	31%
Nov-06	30	9.78	19,149	16,211	15.34%	35%	30%
Dec-06	31	9.47	15,138	16,038	-5.95%	27%	29%
Total	365		210,316	210,316	0.00%	32%	32%
Total in OSP (07/15-09/15)	63	8.90	26,734	26,734	0.00%	24%	24%

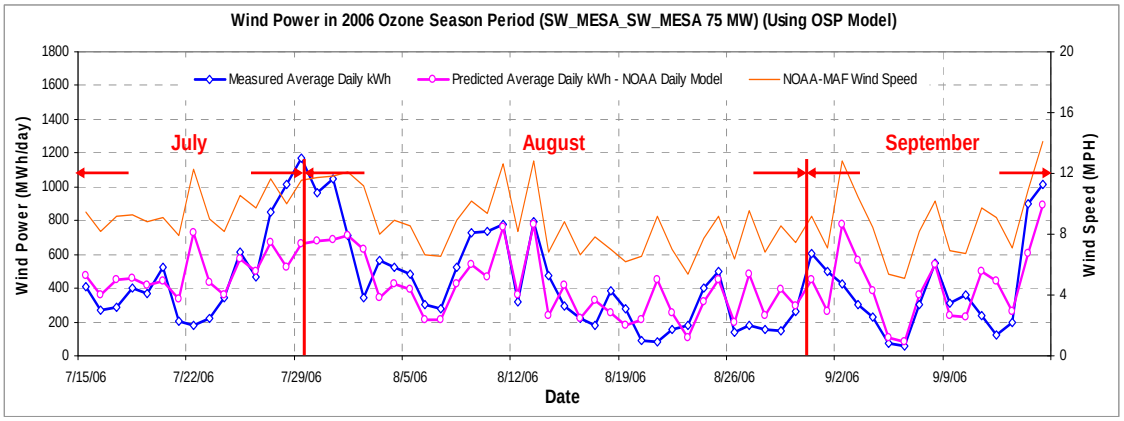

Figure 12-95: SW_MESA_SW_MESA – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

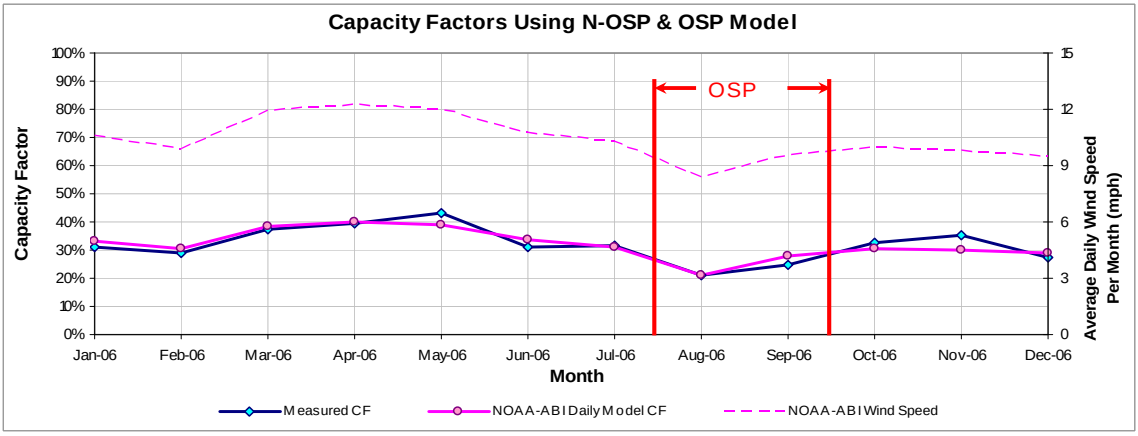

Figure 12-96: SW_MESA_SW_MESA – Predicted Capacity Factors Using Daily Models (2006).

Table 12-95: SW_MESA_SW_MESA – Predicted Power Production in 1999

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	**2006 Measured MWh/yr for Modeling**	**1999 OSD Estimated MWh/day (2006 Daily Model)**	**2006 OSD Measured MWh/day for Modeling**
224,262	**210,316**	**476**	**424**

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.23 Woodward Mountain Ranch (WOODWRD1)

Table 12-96: Site Information for Woodward Mountain Ranch (WOODWRD1).

GENSITECODE_ ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Intercon-nection	Weather Station
WOODWRD1	WIND	McCamey	PECOS	Jul-01	80	FPL/Cielo/TXU	Woodward Mountain Ranch	Vestas V-47 (121)	ERCOT	AEP-West	WTU	FST

SUBGENCODE_ ERCOT	GENSITECODE _ERCOT	Capacity (MW)
WOODWRD1_W OODWRD1	WOODWRD1	80

12.23.1 Woodward Mountain Ranch (WOODWRD1_WOODWRD1)

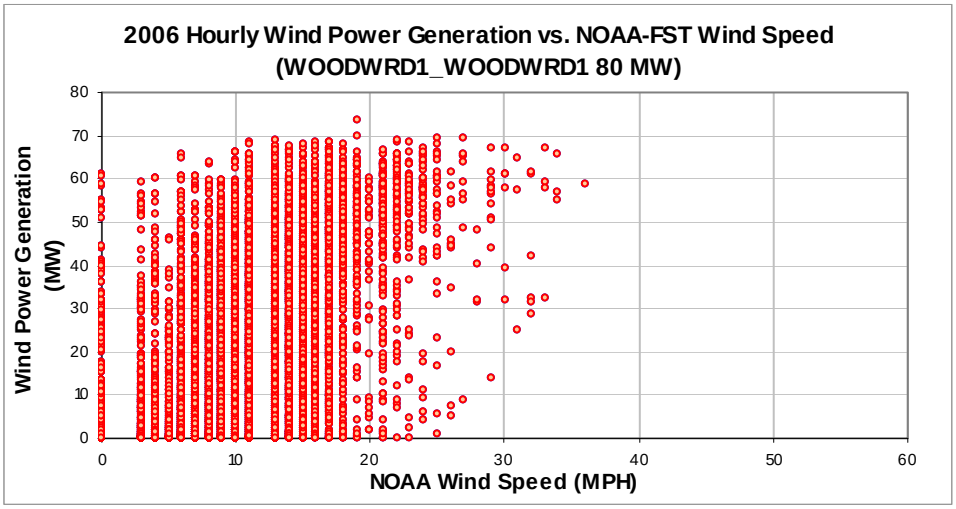

Figure 12-97: WOODWRD1_WOODWRD1 – Hourly Wind Power vs. NOAA Wind Speed (2006).

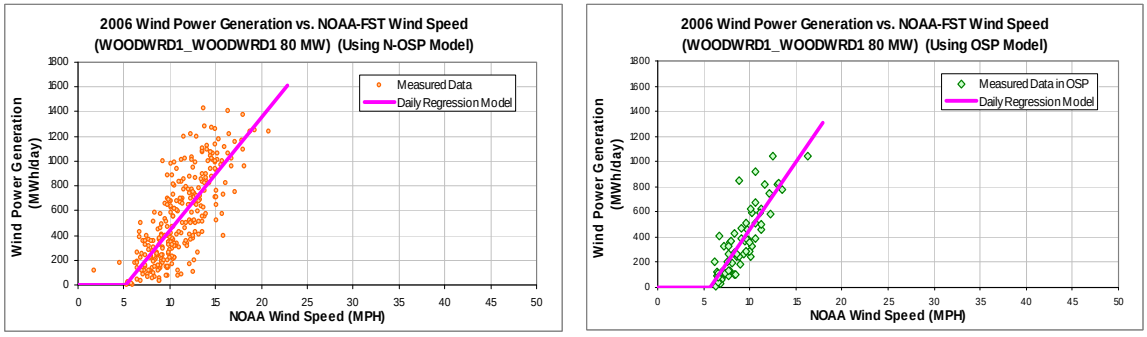

Figure 12-98: WOODWRD1_WOODWRD1 – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-97: WOODWRD1_WOODWRD1 – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-471.94
Left Slope (MWh/mph-day)	90.83
RMSE (MWh/day)	220.53
R2	0.59
CV-RMSE	40.99%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-602.03
Left Slope (MWh/mph-day)	106.58
RMSE (MWh/day)	142.199
R2	0.7134
CV-RMSE	37.6%

Table 12-98: WOODWRD1_WOODWRD1 – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	29	11.08	16,611	15,814	4.80%	30%	28%
Feb-06	28	10.24	13,398	12,817	4.34%	25%	24%
Mar-06	31	11.75	19,378	18,456	4.76%	33%	31%
Apr-06	30	12.12	19,765	18,881	4.47%	34%	33%
May-06	31	12.32	21,269	20,068	5.64%	36%	34%
Jun-06	30	11.07	15,184	16,014	-5.46%	26%	28%
Jul-06	31	10.57	15,696	15,675	0.14%	26%	26%
Aug-06	31	8.91	10,445	10,787	-3.27%	18%	18%
Sep-06	30	9.48	11,144	11,756	-5.50%	19%	20%
Oct-06	31	10.49	15,149	14,917	1.53%	25%	25%
Nov-06	30	10.99	15,554	15,846	-1.88%	27%	28%
Dec-06	31	10.38	11,683	14,603	-25.00%	20%	25%
Total	363	10.79	185,276	185,634	-0.19%	27%	27%
Total in OSP (07/15-09/15)	63	9.20	23,855	23,855	0.00%	20%	20%

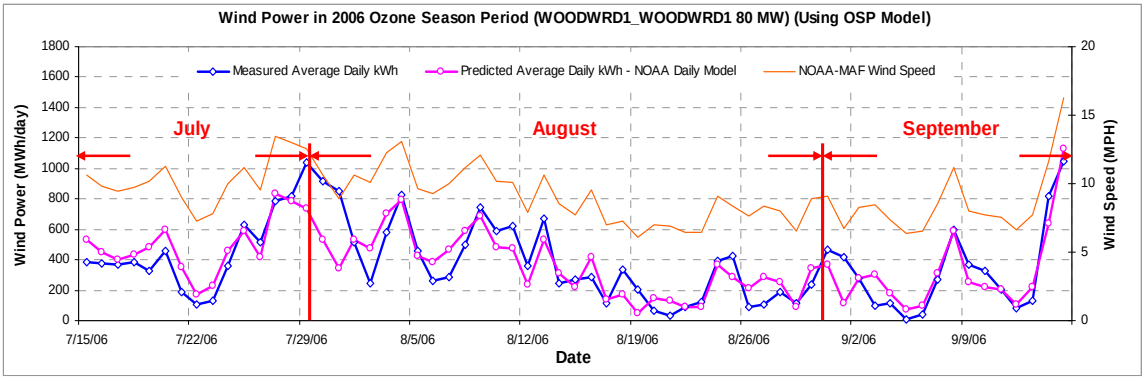

Figure 12-99: WOODWRD1_WOODWRD1 – Predicted Wind Power in OSP Using NOAA Wind Speed (2005).

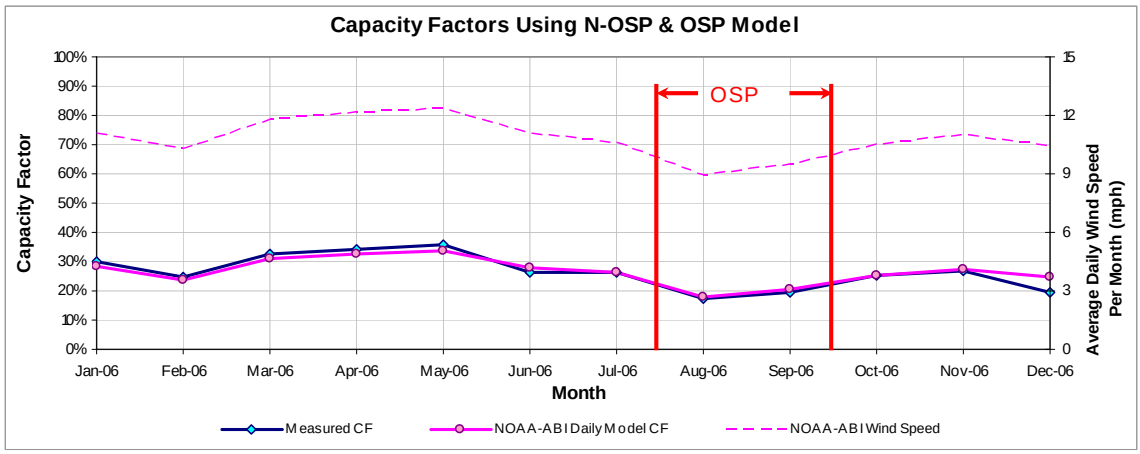

Figure 12-100: WOODWRD1_WOODWRD1 – Predicted Capacity Factors Using Daily Models (2005).

Table 12-99: WOODWRD1_WOODWRD1 – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	**2006 Measured MWh/yr for Modeling**	**1999 OSD Estimated MWh/day (2006 Daily Model)**	**2006 OSD Measured MWh/day for Modeling**
200,746	**186,296**	**459**	**379**

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

12.24 Woodward Mountain Ranch (WOODWRD2)

Table 12-100: Site Information for Woodward Mountain Ranch (WOODWRD2).

GENSITECODE_ERCOT	Renewable Energy	City	County	Date in Service	Capacity (MW)	Company	Facility	Wind Turbine Information	Region	PCA	Intercon-nection	Weather Station
WOODWRD2	WIND	McCamey	PECOS	Jul-01	80	FPL/Cielo/TXU	Woodward Mountain Ranch	Vestas V-47 (121)	ERCOT	AEP-West	WTU	FST

SUBGENCODE_ERCOT	GENSITECODE_ERCOT	Capacity (MW)
WOODWRD2_WOODWRD2	WOODWRD2	80

12.24.1 Woodward Mountain Ranch (WOODWRD2_WOODWRD2)

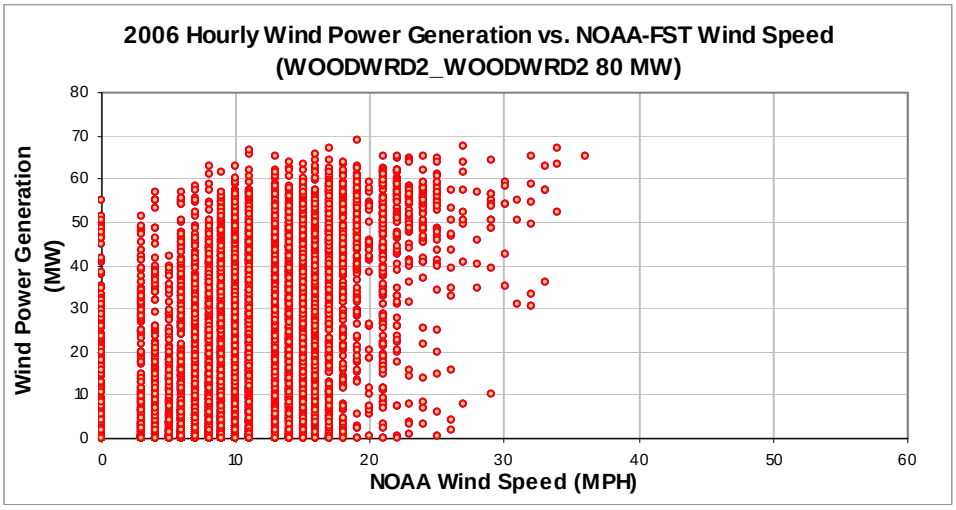

Figure 12-101: WOODWRD2_WOODWRD2 – Hourly Wind Power vs. NOAA Wind Speed (2006).

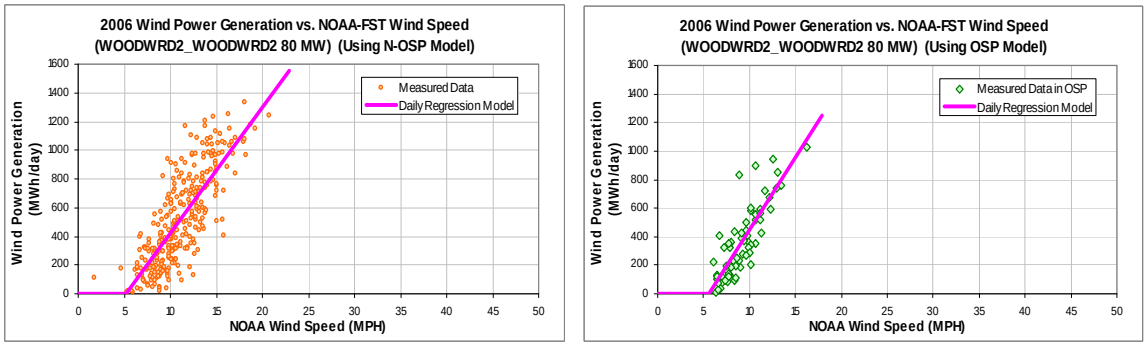

Figure 12-102: WOODWRD2_WOODWRD2 – Daily Wind Power vs. NOAA Wind Speed (Using OSP and Non-OSP Model).

Table 12-101: WOODWRD2_WOODWRD2 – Model Coefficients.

Using Non-OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-457.84
Left Slope (MWh/mph-day)	87.73
RMSE (MWh/day)	197.36
R2	0.63
CV-RMSE	38.13%

Using OSP Model:

IMT Coefficients	NOAA Daily Model
Ycp (MWh/day)	-572.38
Left Slope (MWh/mph-day)	101.5241
RMSE (MWh/day)	136.35
R2	0.7107
CV-RMSE	37.7%

Table 12-102: WOODWRD2_WOODWRD2 – Comparison of Predicted Power vs. Measured Power.

Month	No. Of Days	Average Daily Wind Speed (MPH) NOAA	Measured Power Generation (MWh) NOAA	Predicted Power Generation Using Daily Model (MWh) NOAA	Diff. NOAA	Measured Capacity Factor	Capacity Factor Using Daily Model NOAA
Jan-06	29	11.08	15,279	15,216	0.42%	27%	27%
Feb-06	28	10.24	12,568	12,321	1.97%	23%	23%
Mar-06	31	11.75	18,897	17,761	6.01%	32%	30%
Apr-06	30	12.12	19,286	18,173	5.77%	33%	32%
May-06	31	12.32	20,658	19,318	6.49%	35%	32%
Jun-06	30	11.07	14,323	15,404	-7.55%	25%	27%
Jul-06	31	10.57	14,874	15,018	-0.97%	25%	25%
Aug-06	31	8.91	9,987	10,309	-3.23%	17%	17%
Sep-06	30	9.48	10,709	11,277	-5.31%	19%	20%
Oct-06	31	10.49	14,811	14,343	3.16%	25%	24%
Nov-06	30	10.99	15,202	15,244	-0.28%	26%	26%
Dec-06	31	10.38	11,481	14,040	-22.29%	19%	24%
Total	363		178,076	178,425	-0.20%	26%	26%
Total in OSP (07/15-09/15)	63	9.20	22,793	22,793	0.00%	19%	19%

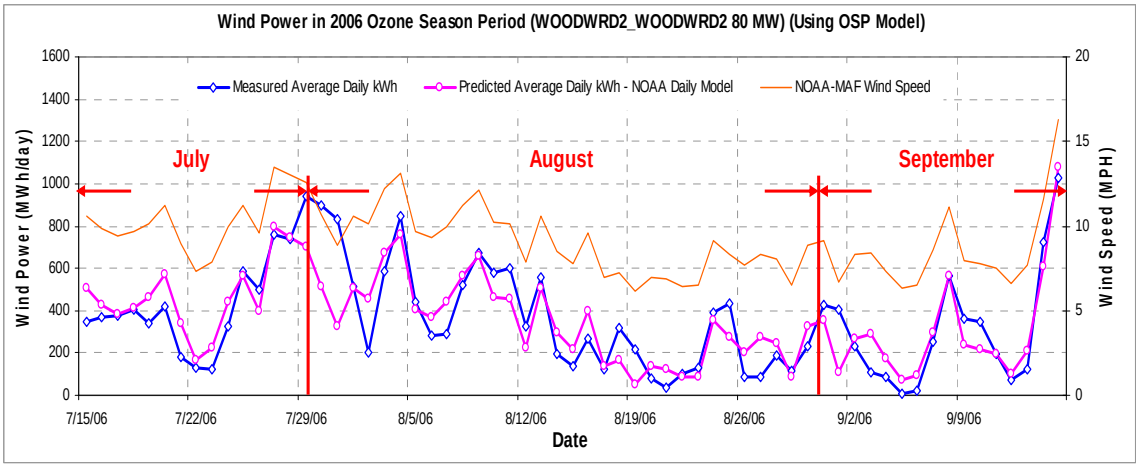

Figure 12-103: WOODWRD2_WOODWRD2 – Predicted Wind Power in OSP Using NOAA Wind Speed (2006).

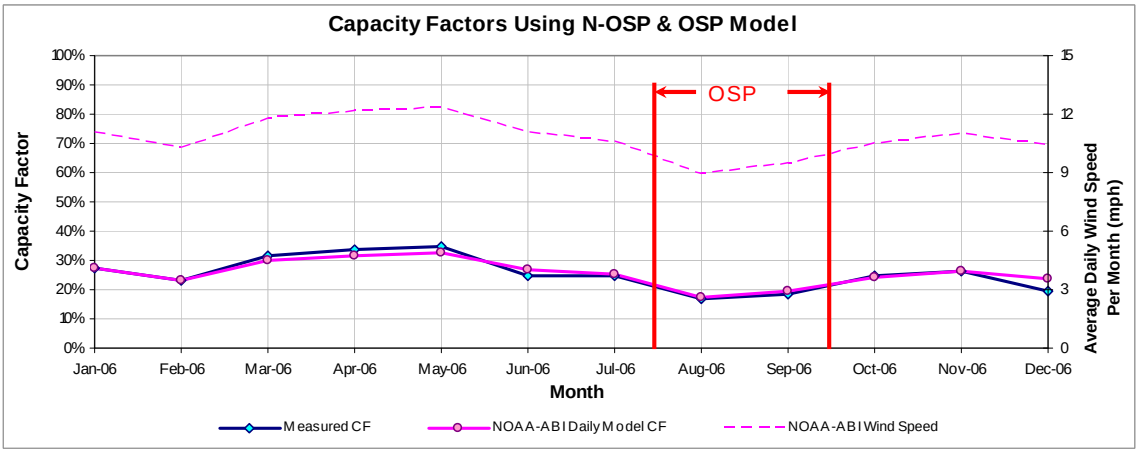

Figure 12-104: WOODWRD2_WOODWRD2 – Predicted Capacity Factors Using Daily Models (2006).

Table 12-103: WOODWRD2_WOODWRD2 – Predicted Power Production in 1999.

Annual		OSD	
1999 Estimated MWh/yr (2006 Daily Model)	**2006 Measured MWh/yr for Modeling**	**1999 OSD Estimated MWh/day (2006 Daily Model)**	**2006 OSD Measured MWh/day for Modeling**
192,956	**179,057**	**439**	**362**

Note: The 2006 Measured MWh/yr presented in the above table included only validated data and it was also adjusted to 365 days. Therefore, this number could be different from the original ERCOT data shown in Table 3-8.

13 APPENDIX C

13.1 Data Files for Wind Energy Production and Weather Files for the Modeling

WT-2008 HARC DATA.xls

13.2 Papers Presented

Liu, Z., Haberl, J. S., Baltazar, J. C., Subbarao, K., Culp, C., Yazdani, B. 2007. "A Methodology for Calculating Emissions Reduction from Renewable Energy Programs and Its Application to the Wind Farms in the Texas ERCOT Region," *Proceedings of the 7th International Conference for Enhanced Building Operations, San Francisco, CA, October 31 – November 2, 2007.*